WATER WORKS AND SEWERAGE

ABC ABP

April, 1935 — L. H. Enslow, Editor — Vol. LXXXII. No. 4

Beautiful and Utilitarian: The Filtration Plant and Pumping Station of the West Palm Beach Water Co., Florida. (Designed by Malcolm Pirnie, Consulting Engineer; Operated by Ralph W. Reynolds, Manager)

IN THIS ISSUE

The Hydraulics of Rapid Sand Filters

Effect of Chlorination on Activated Sludge

Pictorial Presentation of Over 100 Representative American Water Works Plants

Reminiscing on the Installation of Mechanical Filtration Three Decades Ago at Cincinnati

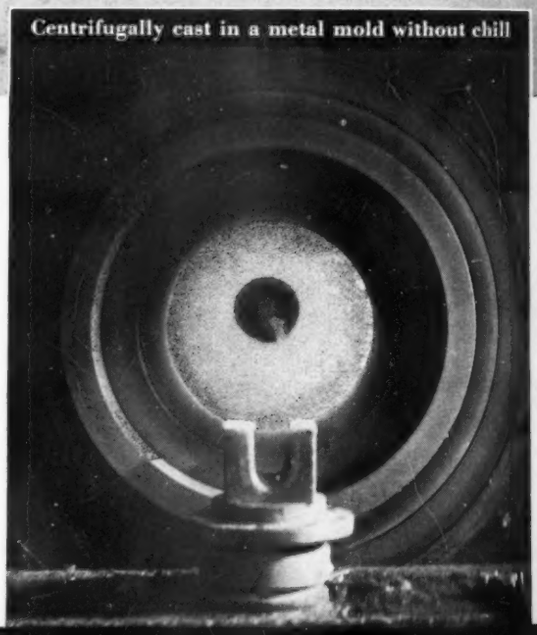
Hydrant Discharge Measurements and Application to Problems of Water Works Operator

Recent installation of Super-de Lavaud Pipe at Chehalis, Washington.

MANUFACTURERS go to great lengths to protect their products from the hazards of transportation as evidenced by the development of specially designed trucks, cars and containers now in use. But in the case of cast iron pipe, increased protection from plant to underground must be inherent in the pipe itself. We have accomplished this by *doubling the impact-strength* of the pipe.

In seeking this maximum protection for our pipe, we have developed and patented a new method of manufacturing cast iron pipe, known as the Super-de Lavaud Process, which is regarded by metallurgists as an important advance in the art of casting gray iron.

Super-de Lavaud Pipe is centrifugally cast in a metal mold without chill. The result—as purchasers of nearly eight million feet of Super-de Lavaud Pipe already know—is a pipe with extraordinary impact-strength, toughness and ductility. The process is explained in a booklet we shall be glad to send upon request.


Centrifugally cast in a metal mold without chill

U.S. SUPER-de LAVAUD PIPE

CAST WITHOUT CHILL IN A METAL MOLD

UNITED STATES PIPE AND FOUNDRY CO., General Office: BURLINGTON, N. J.

WATER WORKS & SEWERAGE

L. H. ENSLOW,
Editor

LEADING ARTICLES To Appear in the Next and Subsequent Issues

Paul Hansen, Consulting Engineer, Chicago and A. R. Garnock, City Engineer, Eau Claire, Wisc. relate interesting experiences and methods employed in locating a ground water supply free from iron and manganese for Eau Claire. Also the plan followed in beautification of the pump station and reservoir is described.

A. M. Rawn, Assistant Chief Engineer, Los Angeles, County Sanitation Districts, will tell of several "Kinks" employed to improve operation and maintenance of sewers and sewage treatment works of the Los Angeles County system.

W. H. Lovejoy, Supt. of Filtration, Louisville, Ky., will disclose some of the "Money Saving Methods in Plant Operation" which have been developed at Louisville. In another article, he will disclose the effectiveness and economy of the flocculators for improved coagulation which Louisville installed.

"Filtration Developments in the Sewerage Field" as reviewed by P. B. Streander, Cons. Engrs., New York City, is an illustrated comparison of the several schemes which have been developed to remove suspended solids from sewage treatment plant effluents by filtration or straining devices.

R. B. Simms, Supt., Water Works and Sewerage, Spartanburg, S. C., will tell of betterments to the Spartanburg distribution system making possible the carrying of heavier peak loads and the expedient of encouraging law sprinkling at special reduced summer-rates. The elevated tank (P.W.A) project adds flexibility to consumer service, makes for satisfied customers. Greater beautification of the city and intangible benefits, if not actual cash register profits, to the Water Department is the result.

I. R. Riker, Engr.-Supt. of Sewerage, Princeton, N. J. will relate experiences with chlorinated iron for odor control at the local sewage treatment works. The scheme employed, in which scrap iron is converted to iron chloride in a chlorinating tower, will be described. Highly satisfactory results and reduced cost of treatment are revealed.

F. E. Stuart, Engr., Industrial Chemical Sales Co., New York City, in a very practical article, brings together a variety of operating and maintenance "Kinks" contributed by water works and sewerage operators from coast to coast.

Mark B. Owen, Supt., Public Works, Dearborn, Mich., will describe the new Herreshoff type of incinerator installed to burn chemical sludge from the Dearborn plant. Operating results and installation and operation costs will be revealed.

Wm. M. Rapp, Supt. Distribution, Atlanta, Ga. Water Department in this issue describes an ingenious (natural) water cooling scheme for outside or inside fountains. In a future issue he will reveal data gathered on the variations in consumption demands by apartment houses and other large buildings—necessary information in planning service lines and meter installations.

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Pictorial Presentation of Over 100 Representative American Water Works Plants

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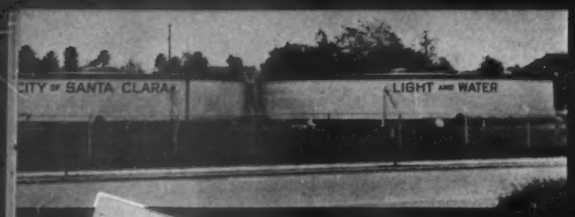
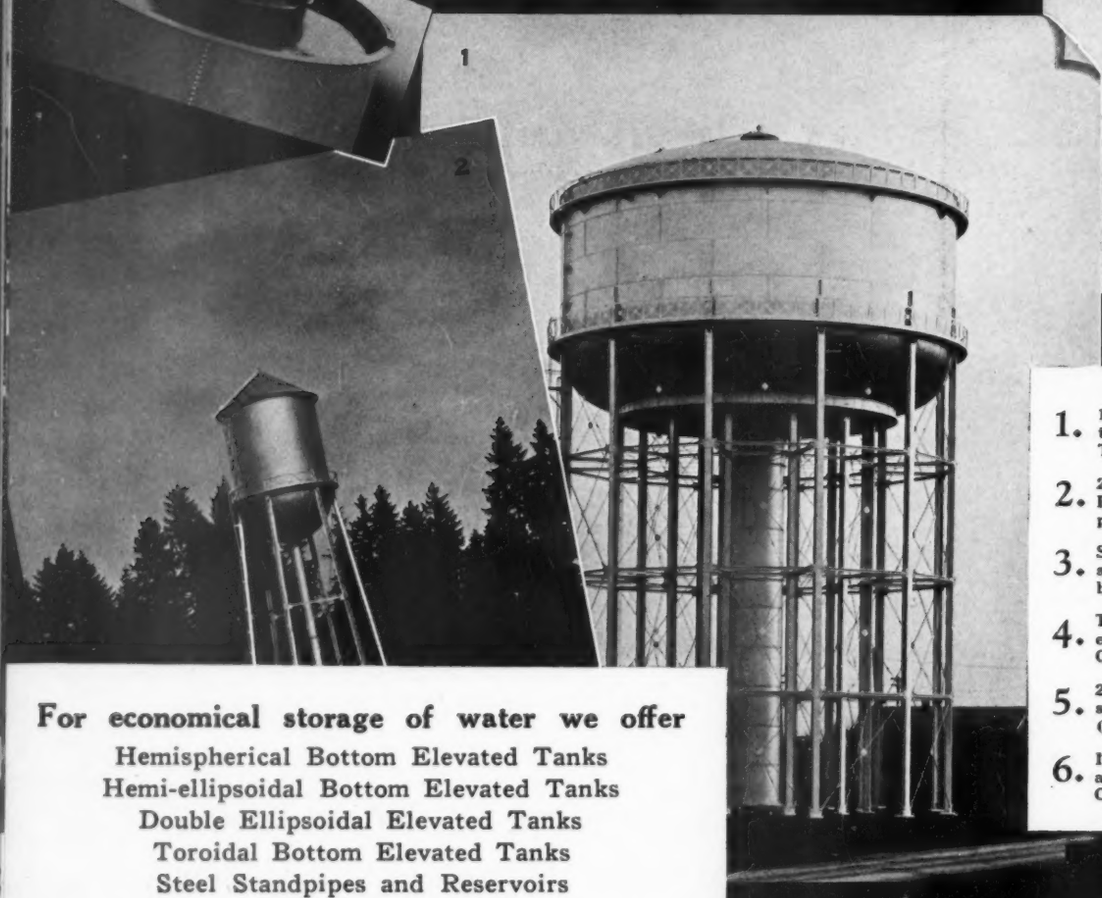
Steel Tanks for Water Treatment and Water Storage





1. 1,000,000-gallon Toroidal Bottom Tank for city of Dallas, Texas.
2. 250,000 - gallon Hemispherical Bottom Tank for city of Olympia, Wash.
3. Steel Sedimentation Tank with spiral baffle—Town of Elizabeth, W. Va.
4. Two 1,000,000-gallon steel Reservoirs for city of Santa Clara, Cal.
5. 275,000-gallon Double Ellipsoidal Tank for Fort Thomas (Ky.) Water System.
6. Incinerators at Dunbar Place and Cruickshank Road, city of Cincinnati.

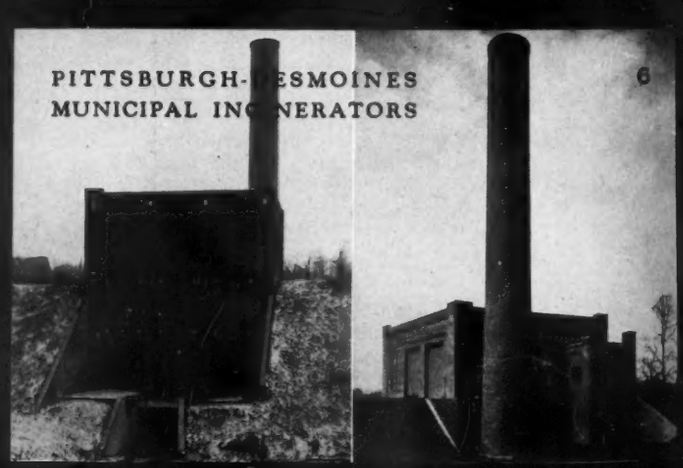
For economical storage of water we offer

Hemispherical Bottom Elevated Tanks
Hemi-ellipsoidal Bottom Elevated Tanks
Double Ellipsoidal Elevated Tanks
Toroidal Bottom Elevated Tanks
Steel Standpipes and Reservoirs

These structures may be built either with or without ornamental treatment. A number of these types are illustrated on this page. For more complete data write for our Modern Water Storage Catalog.

May we also call to your attention the economies and advantages of building your water treatment plant of steel. Let us give you data on steel sedimentation tanks (spiral baffle type), steel filters clear wells, and wash water tanks.

A.W.W.A. DELEGATES—make our exhibit booth your headquarters. If you wish, we can arrange an inspection trip to some of our tanks in the vicinity of Cincinnati or to the Pittsburgh-Des Moines incinerators in which the city of Cincinnati disposes of its garbage and rubbish.



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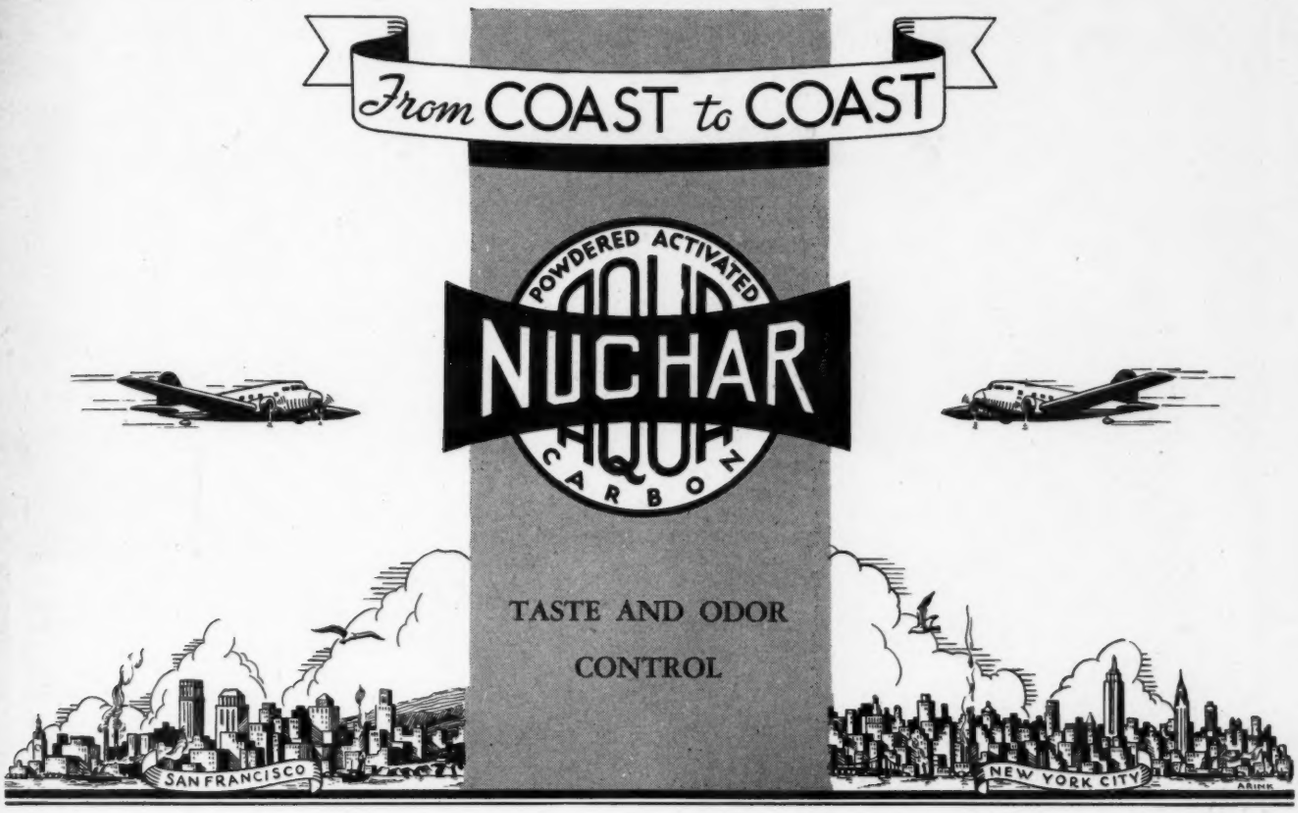

SINCE the period in which Activated Carbon (AQUA NUCHAR) was introduced for taste and odor removal, it has reached the place where it may be truly said to be in demand from coast to coast.

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Within the past year, the larger municipalities have become interested in this treatment. With this interest must come the thought as to the availability of Activated Carbon in quantities sufficient to take care of any demand so created. This, then, is to indicate that our plants at Piedmont, West Virginia, Tyrone, Pennsylvania, and Covington, Virginia, are capable of producing any demand for AQUA NUCHAR. Each plant is fully equipped with a laboratory devoted exclusively to problems of manufacture and use of Activated Carbon—each ready to be of service to any committee appointed by the American Water Works Association.

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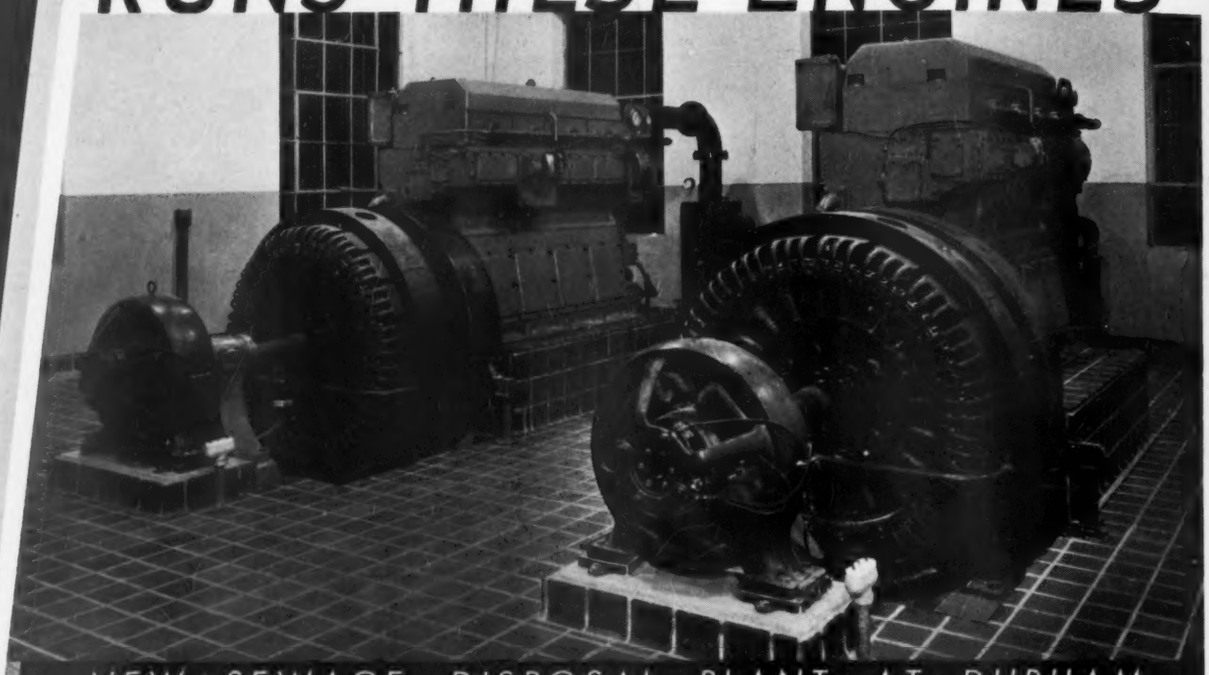
RUNS THESE ENGINES



NEW SEWAGE DISPOSAL PLANT AT DURHAM, N. C., GENERATES POWER FROM WASTE GAS

Such an installation is a quickly self-liquidating investment. All the power for operating and lighting this modern plant is furnished by two Type GN-4 gas engines. Each is rated 150 H. P. at 360 r. p. m. and direct drives 125 K. V. A. (100 K. W.) alternator with direct connected exciter. The excess power is used in their municipal water pumping plant.

Even the heat normally wasted in the exhaust gases is utilized in waste heat boilers to heat water. This hot water, as well as the hot water from the engine jackets, is circulated through coils to heat the sludge digestion tanks.

Cooper-Bessemer gas and Diesel engines are available in sizes from 25 to 1500 H. P. They are built and serviced by an organization which has been building engines for 102 years.

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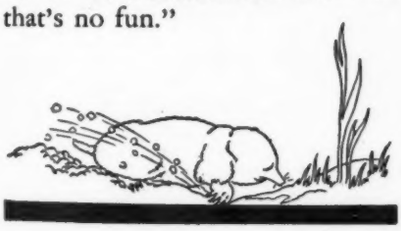
Gas and Power Equipment Company, Birmingham, Alabama

Cooper-Bessemer gas engines utilize by-product gas at the North Side Sewage Plant, Durham, N. C. — a recently completed FERA project, with William E. Piatt (E. E., M. S.) as consulting and designing engineer.

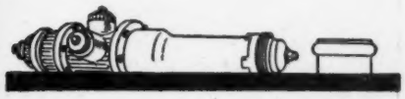
CLUB-CAR WATER WORKS CONVENTION THROWS LIGHT ON DARK PROBLEM

Cincinnati, this year's Mecca for water works men, is just an overnight jump from New York. So you're likely any time to find a miniature convention of three or four delegates airing their troubles in the club car . . . A valuable discussion opens with a New York State superintendent "cussing" his job in winter. He complained, "More grief this winter than ever. Bitter weather, frozen hydrants and then fires. Newspapers riding my department, and us going day and night."

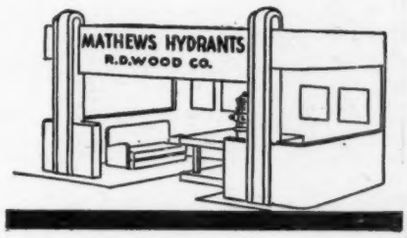
"I wouldn't mind an occasional frozen hydrant connection. We can thaw them electrically. But that's no help when we find joints started, castings broken and hydrants useless. Then we have to blast our way through six feet of frozen ground, with men half frozen—the costs are terrific—and that's no fun."



A superintendent from Carolina spoke up. "We never have frost to argue with. But we did get sick of digging like moles for hydrants broken off by motorists. So we installed Mathews because they have a protection case, and can be removed without digging. Wouldn't that help your frost problem, too?" . . . At that, a Vermonter came into action. "Mathews Hydrants do more than answer the frost problem. They eliminate it. In 20 years, we haven't had a frost-broken hydrant. The grip of the ground is never on the hydrant but on the loose outer case. Frost can heave away to its heart's content, but it never puts any strain on water-carrying parts." New York looked puzzled. "You mean you buy an extra frost case to go around the hydrant?" "No. I mean every Mathews Hydrant comes with a built-in frost case. It doesn't cost an extra cent. And besides its frost-protection feature this cast iron sleeve lets you lift out the entire barrel with all working parts as a unit. You can repair traffic broken hydrants without digging. You can inspect main and drain valves and their seats any time. You can insert a spare barrel and carry the old one back to the shop. Believe me that saves time and money."



"I never knew all this. It sounds like a good buy. Where do you get them?" . . . "They're sold by R. D. Wood Company in Philadelphia. Been made for more than 60 years, and improved steadily. I don't think there's a hydrant problem they haven't met and licked."



The gentleman from Carolina started for bed. "Look up the R. D. Wood booth at the convention. You'll see a working model, and they'll demonstrate with movies how it is repaired when broken."

MATHEWS HYDRANTS

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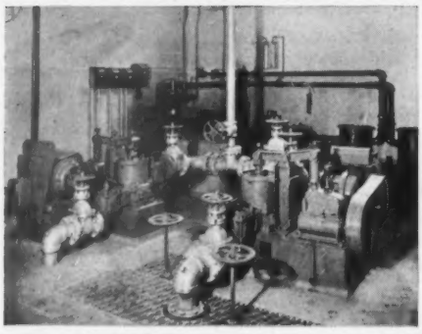
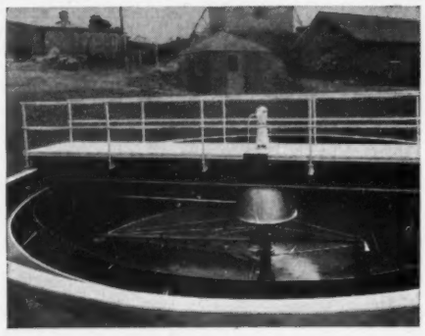
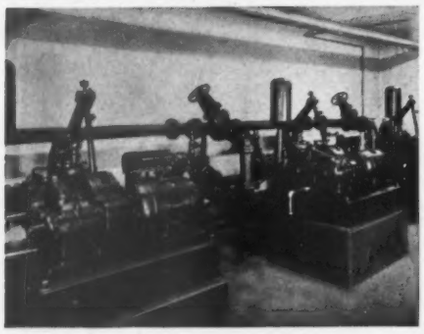
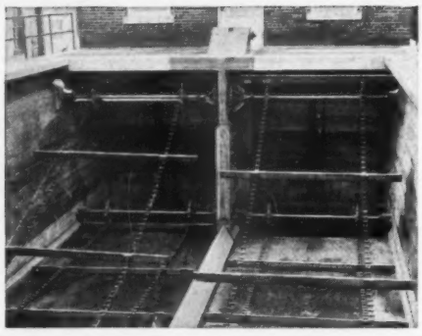
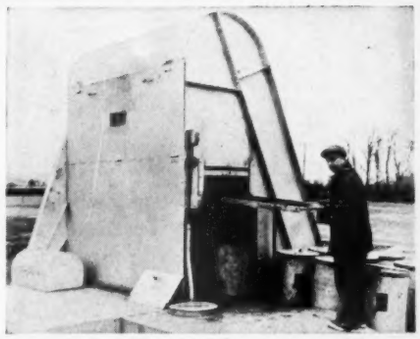




In Sewage Disposal and Water Treatment Plants







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Representation is nation-wide through branch offices in 16 cities, with staff specialists speedily available.

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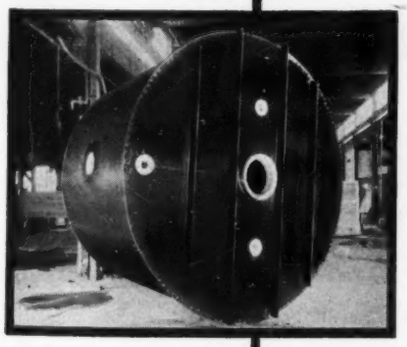

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Not alone for her scenic beauty nor her historic background is Cincinnati of interest to members of the American Water Works Association, for here has been cradled many an idea of importance.

Among Cincinnati's firsts—First strictly municipal University in the United States. The instigation of the co-operative educational plan. The first major city to adopt City Manager form of government. The first major city to adopt a law to enforce a comprehensive plan for the development and construction of streets, sub-ways, bridges, playgrounds and parks.

A city such as this has much to offer a visitor which, together with a full program of interesting and instructive technical papers and a splendid series of entertainment features, will make your trip to Cincinnati an outstanding event of the year.

You must be there May 6th - 10th.

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55th ANNUAL CONVENTION
CINCINNATI MAY 6th—10th

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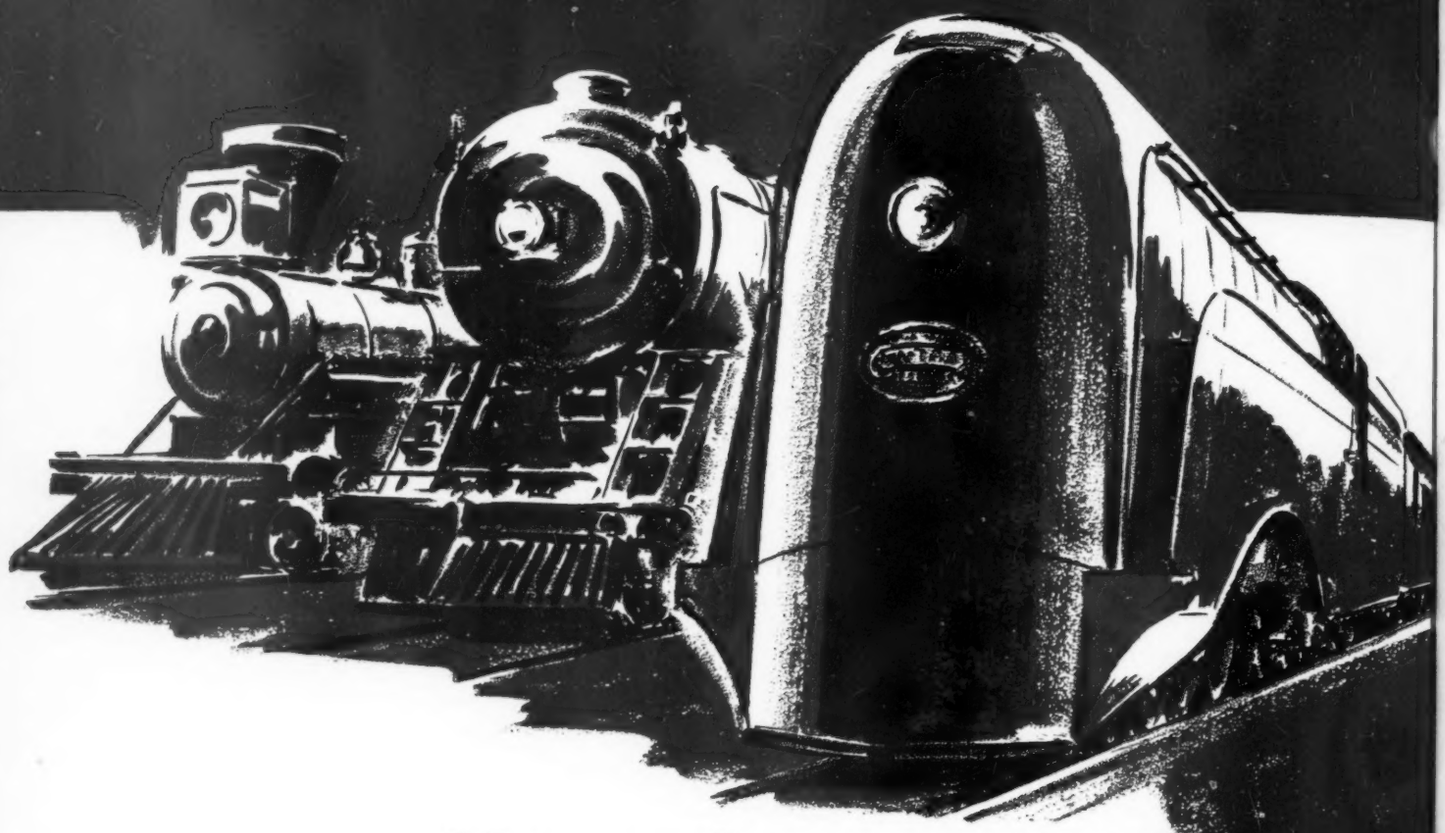

Boiler water supplies were never more important than they are today. Modern locomotives . . . powerful . . . highly efficient . . . require boilers that will stand up under heavy steam demands and that can be kept in continuous service for extended periods.

Nalco Water Treatment has kept pace with locomotive development. Better treating materials have been introduced . . . automatic and inexpensive treating equipment has been designed . . . methods have been simplified.

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April 2,1935

To the Water Works Men of the Country:

As Chairman of the American Water Works Association Convention Management Committee, I am glad of this opportunity to extend an invitation to all water works men to attend our Cincinnati meeting.

At this four day international conference, May 6 - 9, there will be a free exchange of ideas together with questions and answers on all phases of the water works industry. Leaders in all the branches of the industry, will be present and take part through the presentation of papers and the discussions. The water plant operators will try to solve their everyday problems at the Round Table conferences.

In the 100 booth exhibit hall, the manufacturers will show their latest developments as well as their time proven processes and products, and will have expert representatives to explain and give advice to those in attendance.

The evenings are given over to entertainment, with a boat trip planned for Wednesday afternoon. The ladies are welcome to all of the social affairs and will also have special entertainment provided for them.

Only once a year is this opportunity given to water works men to come in contact with their fellow-workers from the United States and Canada.

Our message to all water works men is: DON'T MISS THE CINCINNATI CONVENTION.

Sincerely yours,
Wm W Brush
Wm.W.Brush,Chairman,
Convention Management Committee

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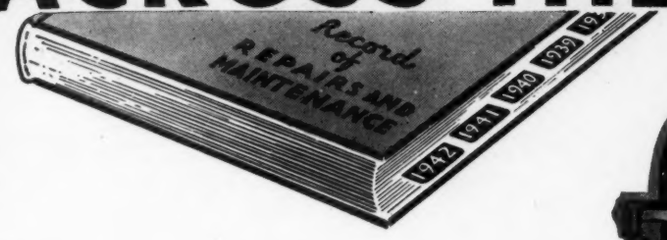

See the MUELLER COLUMBIAN EXHIBIT
Booths 301, 302 and 303
AMERICAN WATER WORKS ASSOCIATION
CONVENTION, CINCINNATI, MAY 6-10

IT is a safe bet that the same things will happen to your fire hydrants in the next five years that happened during the last five years. This means that in a city of any size there will be a number of smashed hydrants—a number of main valves to replace—a number of hydrants to be lengthened—a number of other changes and repairs to be made.

If the hydrants smashed by trucks or automobiles are Columbians, (with the safety flange and coupling) the cost of repairing breakage will be about five dollars. But if they are hydrants that lack this feature, it will be about $50.00! To remove the main valve of the Columbian with its bronze shoe bushing will be a simple job. To remove a main valve when the seat ring is "frozen" into an iron thread in the shoe, is a tough job usually involving a lot of digging and lifting. If the grade level changes the Columbian can be lengthened to conform to any new grade in less than 20 minutes, but usually the lengthening of a hydrant is a job that calls for a lot of digging and lifting—often, water cut-off.

Figure the excessive cost of these repairs and the time and money wasted in making them. Figure the excessive cost of replacing ordinary oak tanned leather main valves which offer half the service life of the special chrome tanned leather used in Columbians. Figure the cost of endless oiling—totally eliminated in the self-oiling Columbian. Figure the cost of breakage from freezing—eliminated in the non-freezing Columbian. You will then know why so many cities are now installing only Columbians.

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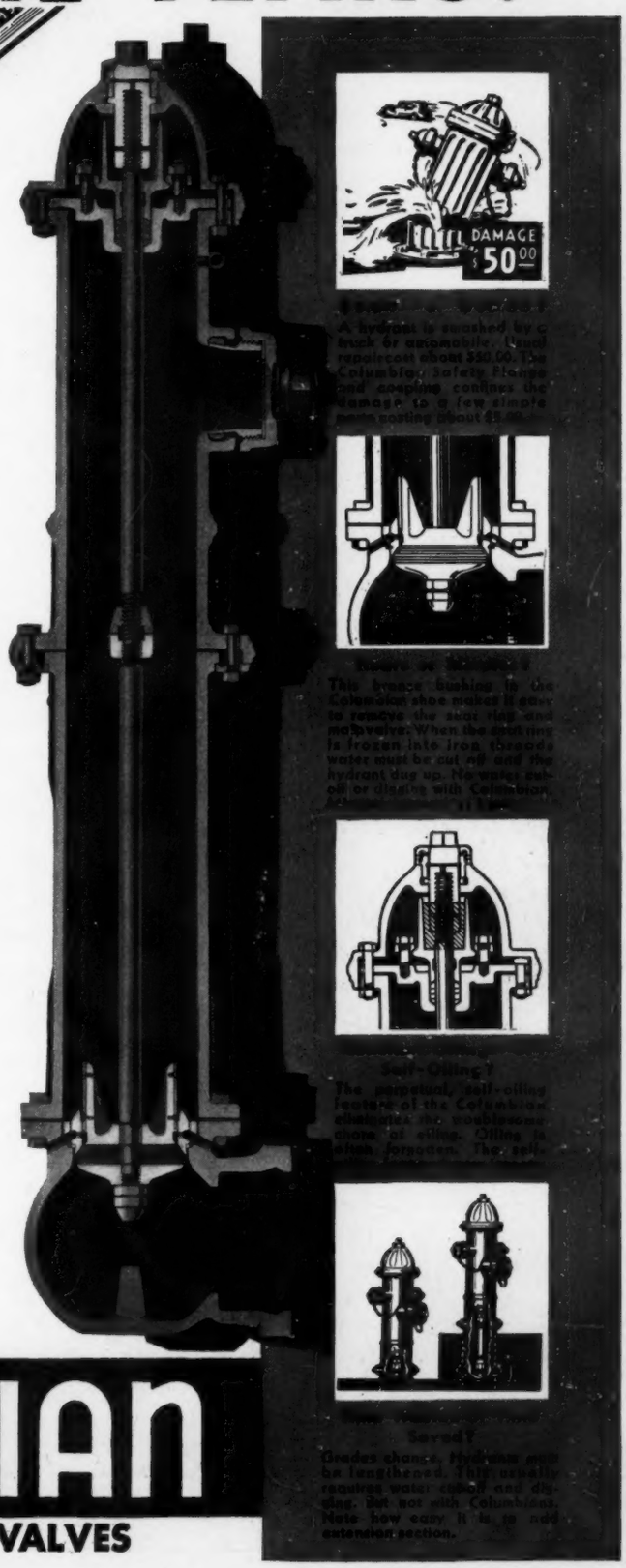

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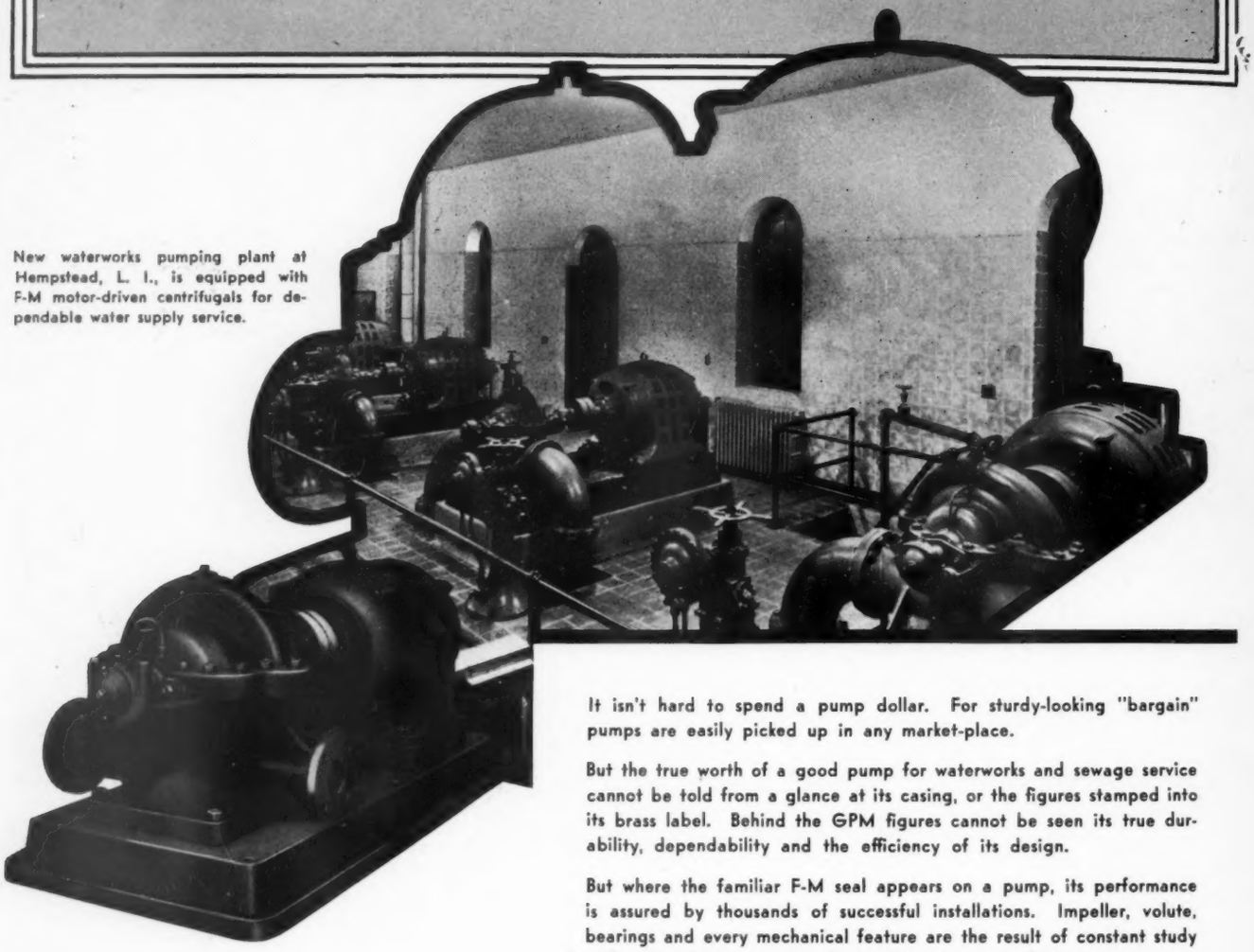

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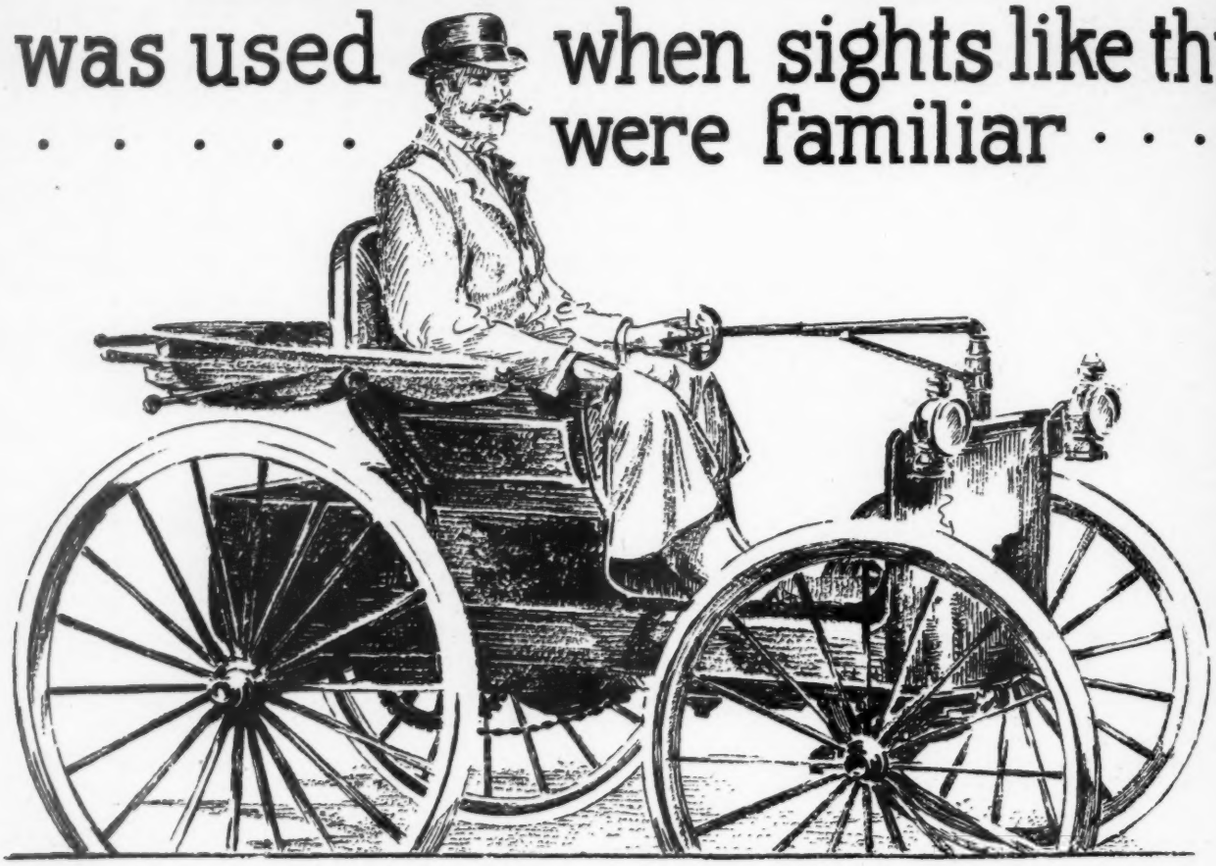

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Saves at least 75%.

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What Mr. Foutz of the La Porte Water Works says about HTH ...

"WE believe HTH to be the best thing of its kind for the treatment of water systems," says C. C. Foutz, prominent in water works circles and superintendent of the La Porte Water Works, La Porte, Indiana.

"We first used HTH here about six years ago. At that time this plant was re-built and filtering beds installed. Following this construction work the B coli count was dangerous and after some investigation as to what we could do to correct it we purchased our first supply of the product and sterilized the entire plant including aeration, settling and clear water basins, pumps and filters. The situation was immediately cleared up and we experienced no further trouble.

"Following this we used HTH to clear up occasional contamination in our wells until the installation of our present chlorination plant four years ago. We also use it in the periodical cleaning of our basins and filters; in the installation of all new mains; and for sterilizing after any construction work around the plant.

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"We feel, therefore, that we are qualified from wide experience to recommend its use to all those responsible for the safeguarding of water supplies."

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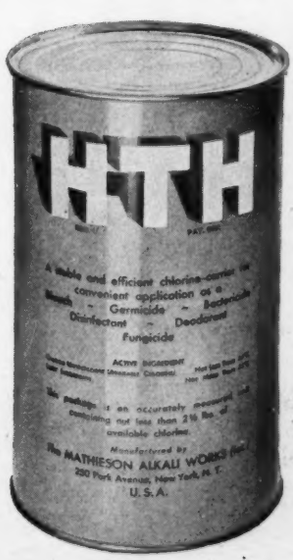
View of La Porte Water Works showing filter house at left, pump house at right and aerating basin at extreme right. C. C. Foutz, superintendent, recommends HTH "to all those responsible for the safeguarding of water supplies."



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1. Easy Melting.
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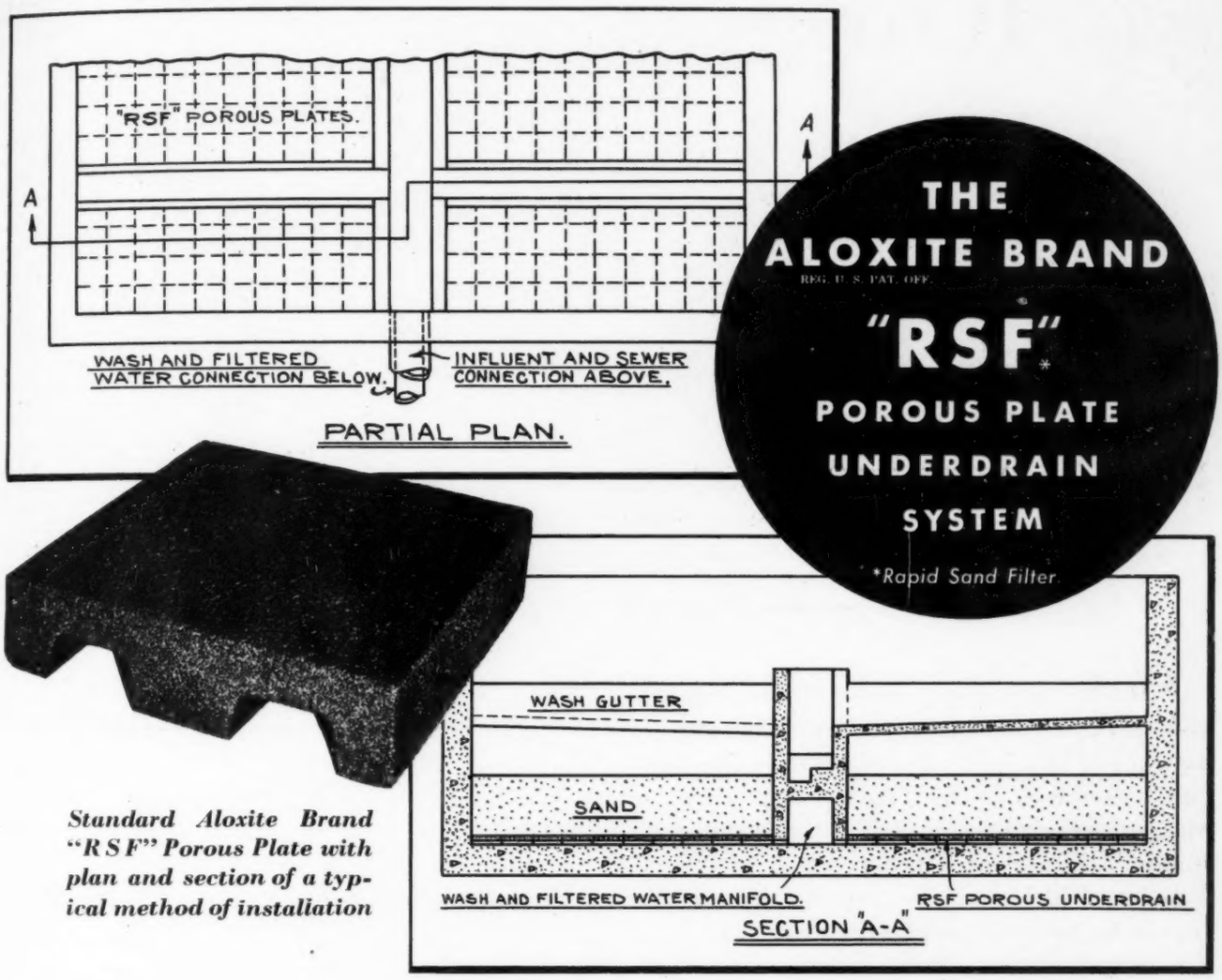

Standard Aloxite Brand "R S F" Porous Plate with plan and section of a typical method of installation

THE ink was hardly dry on our first announcement of this improved system before hundreds of interested Engineers and Waterworks Superintendents inquired for complete details.

The flood of inquiries definitely showed the need for this new underdrain system—the most outstanding improvement in filter design in recent years.

The new underdrain system employing Aloxite Brand "R S F" Porous Plates offers these distinct advantages:

- Uniformity of backwash.
- Permanent protection against disruption of sand bed.
- Elimination of gravel layers.
- A chemically inert filter bottom.
- Plates bonded directly to filter floor—no ridges or holding down bolts.
- Reduced operating heads, both filtering and backwashing.
- Air wash without auxiliary equipment.

Our sanitary engineers will gladly discuss this new system with you

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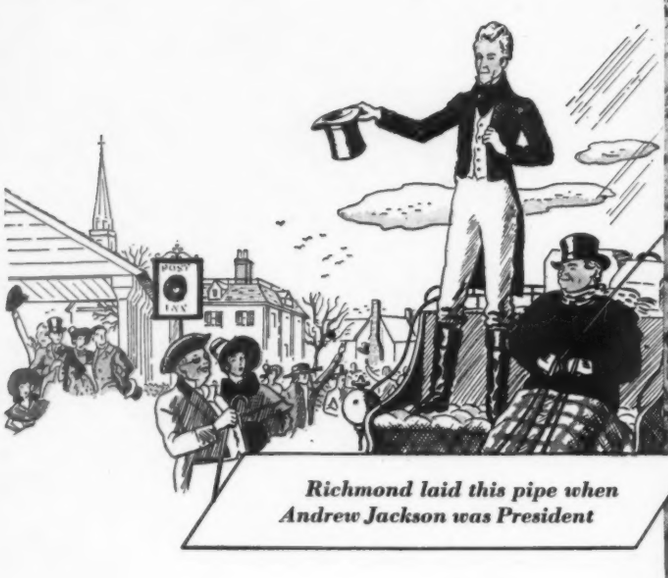

Richmond laid this pipe when Andrew Jackson was President

AFTER 88 years of service in its original location, this cast iron main was taken up in 1918 to be replaced by a larger line of cast iron pipe, and relaid elsewhere. In 1931, after 101 years of service, it was again uncovered, inspected and photographed. Officials of the Department of Public Utilities of Richmond, Va., report that this old pipe is still rendering satisfactory service and good for many more years. It is another confirmation of the fact that the useful life of cast iron pipe with bell-and-spigot joints is more than a century.

The four major economies resulting from the long life of cast iron pipe are due to its effective resistance to rust. Cast iron is the one ferrous metal for water and gas mains, and for sewer construction, that will not disintegrate from rust. This characteristic makes cast iron pipe the most practicable for underground mains since rust will not destroy it.

The 4 *Economies of* Cast Iron Pipe

1. Official records of cast iron pipe laid 100 to 200 years ago and still in service, prove that it is *cheapest in the end.*
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3. Long-lived pipe obviously causes less street-opening for replacements and repairs. Therefore, cast iron pipe *saves money on street-openings.*
4. When replaced by larger pipe, or a main is abandoned or rerouted, cast iron pipe *pays a final dividend in salvage value.*

For further information, address The Cast Iron Pipe Research Association, Thomas F. Wolfe, Research Engineer, 1015 Peoples Gas Bldg., Chicago, Ill.

CAST IRON PIPE

METHODS OF EVALUATING BIDS NOW IN USE BY ENGINEERS RATE THE USEFUL LIFE OF CAST IRON PIPE AT 100 YEARS

TRADEMARK REG.

Filter Operating Gallery, Meander Creek Plant, Mahoning Valley Sanitary District.

WATER WORKS AND SEWERAGE

A GILLETTE PUBLICATION

VOL. LXXXII APRIL, 1935 NO. 4

THE HYDRAULICS OF RAPID SAND FILTERS

Some References, Comments and Examples

By G. GALE DIXON

Consulting Engineer, Youngstown, Ohio

G. Gale Dixon

AN immense amount of research in connection with filter sand and the hydraulic performance of rapid sand filters has been conducted and the results have been recorded by many men during the past twenty years. In the present writing, which is an amplification of a paper recently presented before the Ohio Conference on Water Purification, the conclusions of some of these investigators are set forth and discussed in relation to the practical aspects of the hydraulic design of a filter plant. To cite a specific example, data are displayed from a study of the hydraulics of the washing system for rapid sand filter units of 4 M.G.D. capacity, which involved a comparison between alternative designs of filter underdrain systems.

The Optimum Rate of Wash

One of the most important contributions to the technique of washing rapid sand filters was the investigation made at Detroit by Hulbert and Herring,[1] the conclusions from which may be summarized as follows:

(a) The presence of a permanent gelatinous coating on the sand grains of a filter bed is *not* necessary for efficient filtration; rather, it appears to be detrimental.

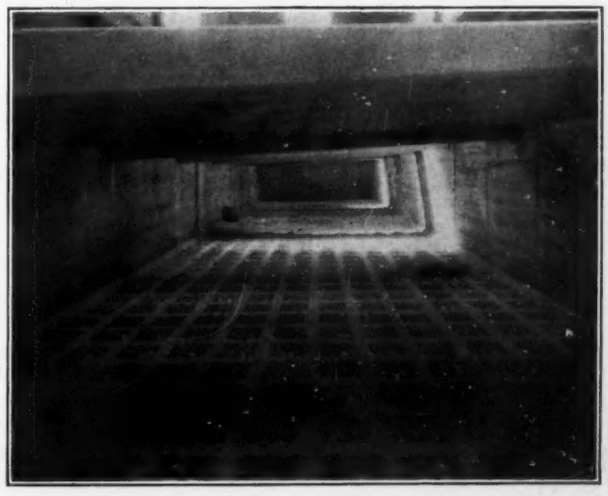
(b) If the sand is completely cleaned at each washing, the accumulation of "mud" in the bed and the subsequent shrinkage and cracking of the bed will be prevented.

(c) The sand can be kept clean by regularly applying the upward wash at such rate as is necessary to cause an expansion of the sand bed to approximately 150 per cent of its volume in repose.

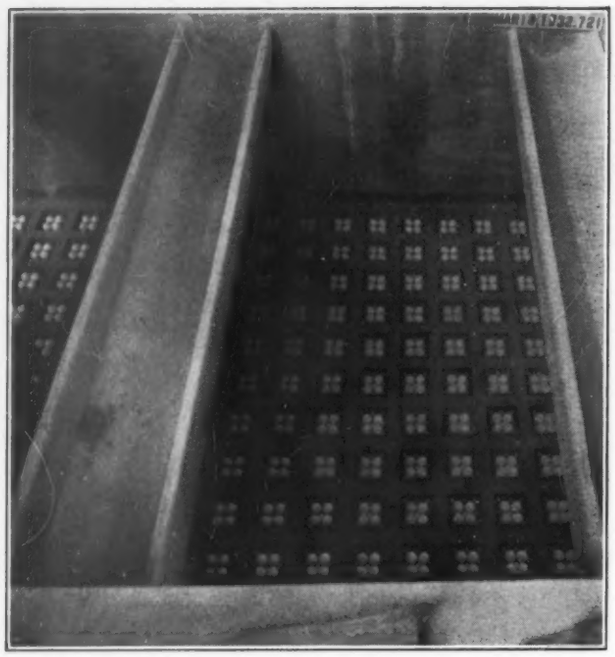
(d) The rate of application of wash-water which is necessary to accomplish the optimum expansion of a bed of any particular sand varies in inverse function with the viscosity of the wash-water and hence in direct function with its temperature.

(e) The size of sand grain which appears to have the greatest significance, in correlation with the performance of a given sand under the washing condition, is shown to be the size such that 30 per cent (by weight) of the grains are finer than it.

In joint discussion of this paper, Wolman and Powell (Ibid., P. 1511) questioned the necessity for very high



Wheeler Filter Bottom—Depressions Leveled Up with Coarse Gravel, Ready for the Several Layers of Graded Gravel.



Wheeler Filter Bottom—Large and Small Balls in Place Ready for Gravel.

rates of wash. They expressed the view that the formation of mud balls and the cracking of the sand surface in filters washed at the rate of 24 or more inches per minute was, in their experience, due to the use of too fine a sand or to the presence of foreign matter in the bed, or both; and that the condition could be cured by the substitution of clean sand with effective size of 0.45 mm. or more.

The influence of size of sand upon the rates of wash-water necessary for 50 per cent expansion of the bed at the seasonal extremes of temperature encountered in the latitude of the North Central States is shown in Table No. 1. It will be noted that increase in the 30 per cent size from 0.40 mm. to 0.60 mm. requires the doubling of the rate of wash, while at summer temperature an increase in wash rate by some 50 or 60 per cent over the winter condition is necessary.

TABLE NO. 1

Rate of Application of Wash Water in Inches Rise Per Minute Required for 50 Per Cent Expansion of Bed of Various Sizes of Sand. (Hulbert and Herring).

30 Per Cent Size— *MM.*	*Temperature of Wash Water* 32° F.	70° F.
40	12.3	20.2
50	18.5	29.2
60	25.3	39.0
70	32.7	49.3
80	41.3	60.3

Initial Loss in Filtration

Considerable experimentation and study of a high order has recently been devoted to the loss of head in filtering water through beds of clean sand of varying characteristics, notably by Tyler,[6] by Hulbert and Faben,[12] and by Fair and Hatch.[13]

One of Tyler's statements is quoted:

"If the head losses in a sand vary in some way in proportion to the surface area of the sand, * * * one might define the mean diameter of sand grain, from this standpoint, as such a diameter that the particles finer than this diameter have a surface area equal to that of the particles coarser than it. Such a sand grain we may term the surface median, and a determination of its value from these data indicates that it is the diameter, on the average, of that grain than which 31.1 per cent is finer."

This thought is interesting in relation to Hulbert and Herring's subsequent finding[11] that the size of the 30 per cent grain is the best index as to the performance of a sand in washing.

Hulbert and Faben's general findings[12] may be summarized as follows:

The loss of head varies:

(1) Directly with the rate of flow;
(2) Directly with the depth of the sand bed;
(3) Inversely as a function of the temperature of the water—the loss at 32° F. being something of the order of 1.7 times that at 70° F.;
(4) Inversely with the sizes of sand grains in the various layers making up the bed as hydraulically graded by the washing process.

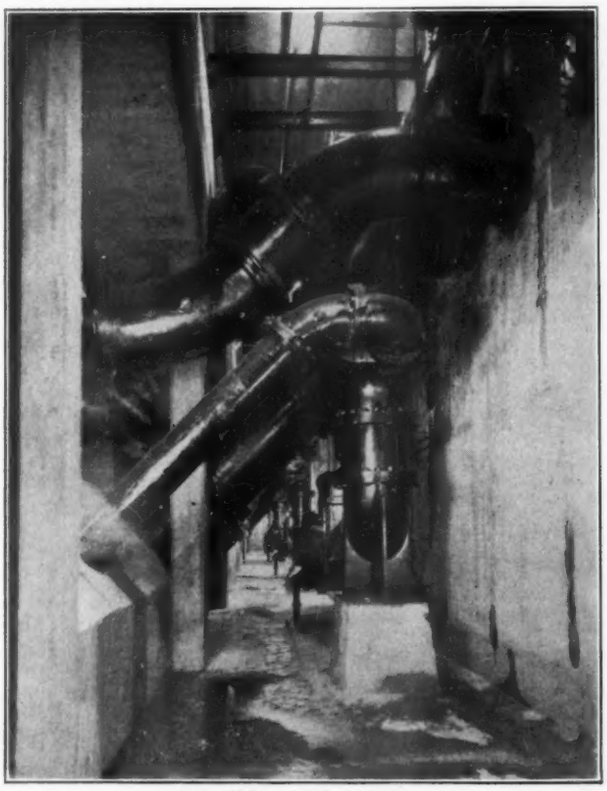
Fair and Hatch report[13] the relative numerical importance of various factors for the filtration of cold water through clean sand as follows:

	Loss-of-Head Ratio
(1) Temperature variation—68° F. to 32° F.	1:2
(2) Porosity variation—45 to 35 per cent	1:3
(3) Variation in shape of sand grain—rounded to angular	1:1.6
(4) Uniformity coefficient—	
(a) Slow sand filters—2 to 3	1:1.4
(b) Rapid sand filters—1.4 to 1.6	1:1.1
(5) Effective size—	
(a) Slow sand filters—0.35 to 0.25	1:2
(b) Rapid sand filters—0.60 to 0.35	1:3

For usual designs, the initial loss in a filter will commonly be about one foot in the sand bed, with a total of perhaps 3 feet including losses in the individual filter piping and controller.

Loss of Head in Washing

The head loss in washing a filter, from wash water tank to lip of gutter, is the sum of the individual fric-



One Side of Pipe Gallery.

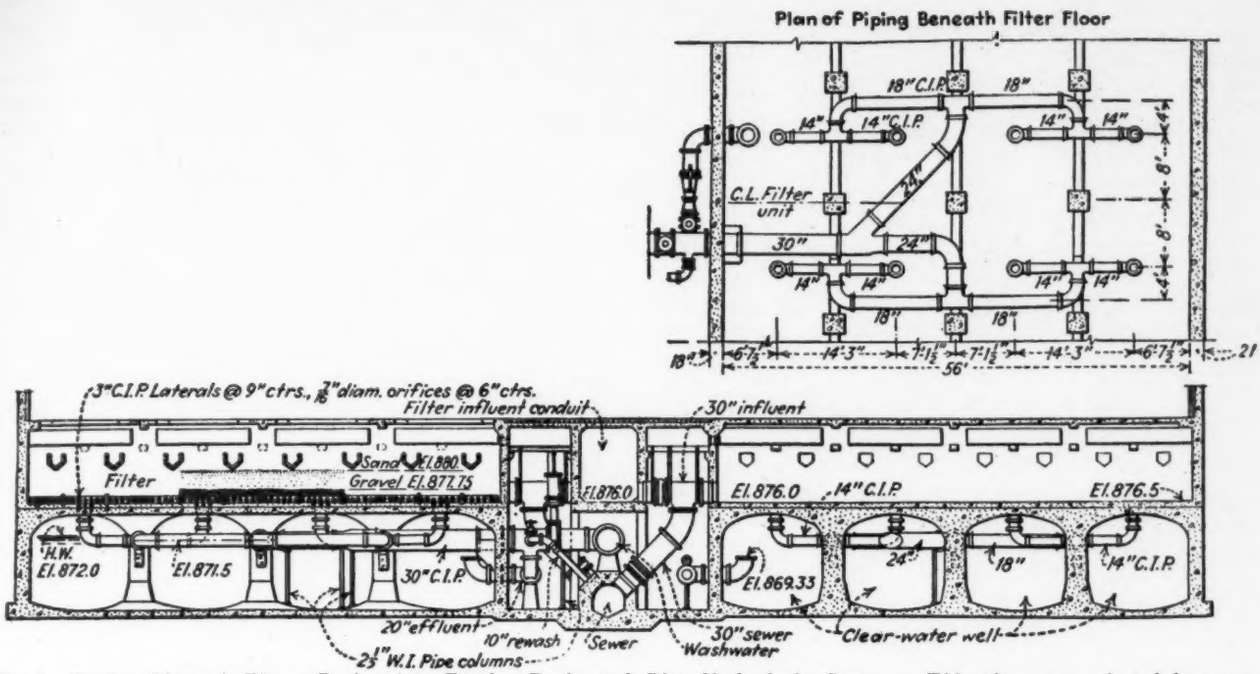


Fig. 1—Section Through Filters Designed to Employ Perforated Pipe Underdrain System. This plan was rejected because of greater cost and less satisfactory hydraulic performance than the alternate false bottom design.

tion losses in the following several parts of the system: (a) Underdrain system; (b) Gravel; (c) Sand; (d) Head over lip of gutter; (e) Piping of individual filter; and (f) Main wash water piping.

The performance, in washing, of the various types of underdrain systems in current use has been quite thoroughly established by experimentation. The perforated pipe system has been reported upon by Jenks,[4] by Ellms,[9] by Enger and Levy,[10] and by Carson[14]; the Wheeler filter bottom by Barbour.[3]

The loss through graded gravel of the usual proportions is small, and has been reported by numerous investigators. It may be taken at 0.1 ft. for 12 inches thickness of bed and a wash rate of 12 inches per minute, and in direct proportion for other thicknesses and rates.

Loss of head in the sand bed builds up rapidly with increase in the rate of wash until the sand is put in complete suspension. Thereafter, it remains constant with increasing rates of wash, according to some investigators, but others report a progressive slight increase.

Assume a bed of sand 12 inches thick, with specific gravity of 2.65 and 40 per cent voids. Then the height of a column of water of weight equal to the submerged weight of the sand will be $(2.65 - 1.00) \times (1.00 - 0.40) \times 1.00 = 0.99$ ft. It seems obvious that there will be a progressive slight increase in loss of head with

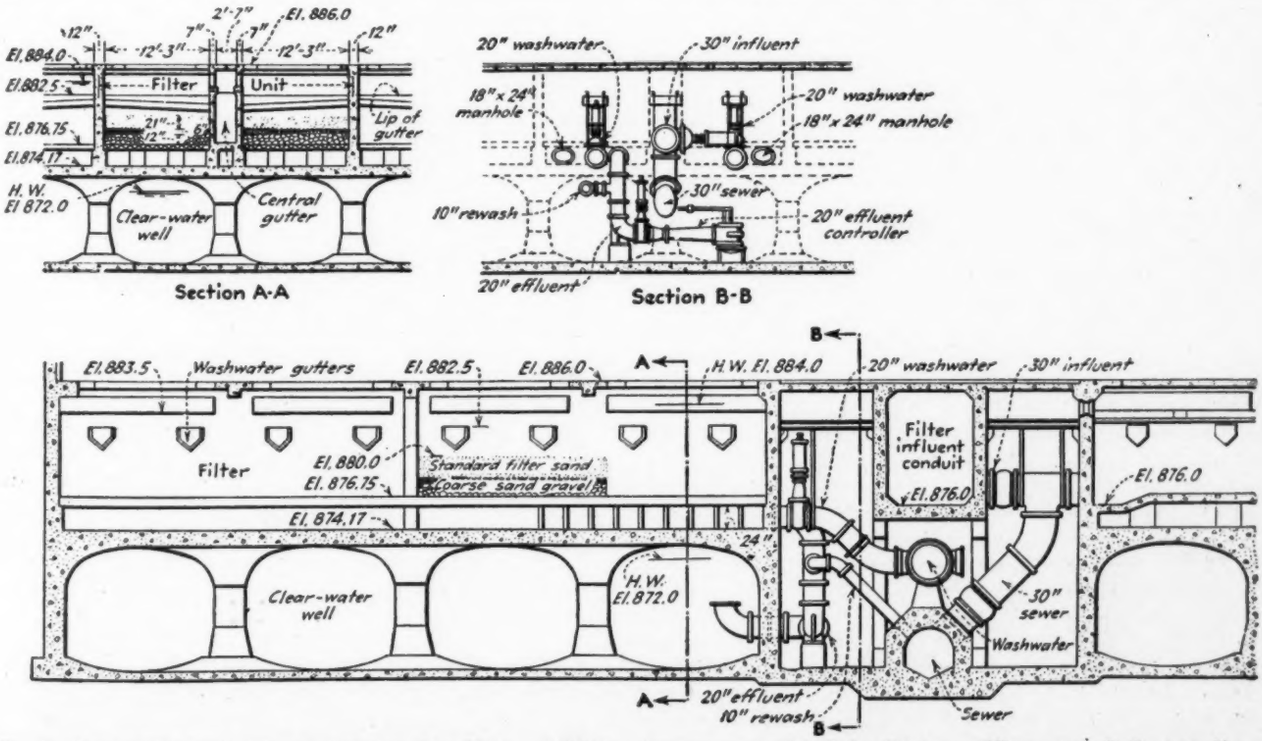


Fig. 2—Section Through Filters Showing Simplicity of Piping Arrangement with False Bottom. Filters were built according to this design.

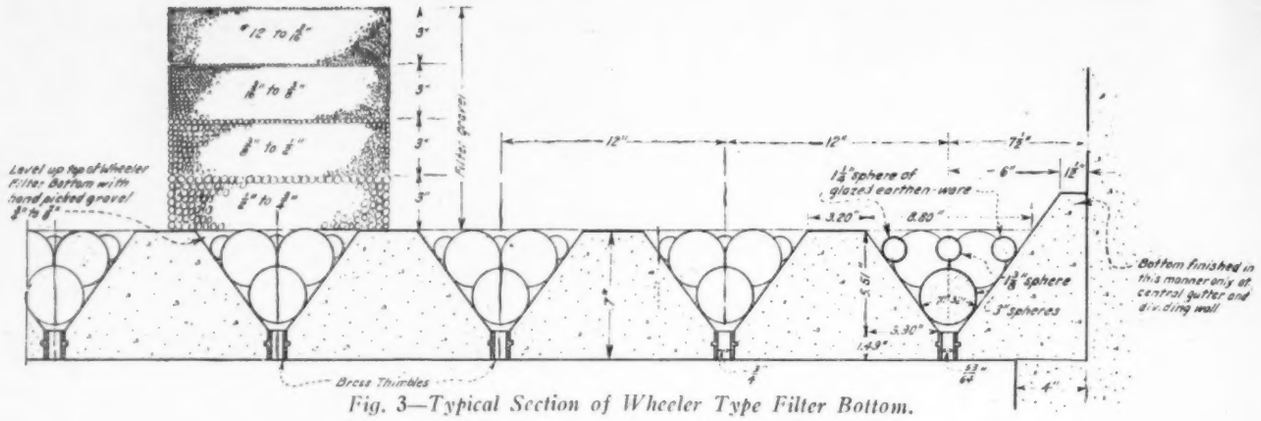


Fig. 3—Typical Section of Wheeler Type Filter Bottom.

increasing rates of wash, as the increasingly turbulent motion of the sand grains must register increasing expenditure of energy. But for the practical purposes of design, the loss of head in the sand bed during washing may be taken as equal to the depth of the bed at rest—including the depth of the "torpedo sand," if any, interpolated between the standard filter sand and the graded gravel.

The head over the lip of the wash water gutters will be that which is necessary to produce free weir discharge—assuming that the gutters and drainage system are properly proportioned to avoid back-flooding. The method of computing capacity of lateral wash water gutters set forth in Appendix "B" of J. W. Ellms' book on "Water Purification" gives satisfactory results.

The losses of head in the large piping of the individual filter and in the main wash water piping may be computed according to the usual methods of hydraulic analysis. Special allowance must be made for loss in the wash-water controller, if one is used.

The effect of seasonal temperature change upon the viscosity of the water is not of practical importance in computing pipe friction. It may make a difference in skin friction in pipes of the sizes commonly used amounting perhaps to 10 per cent in underdrain laterals and 5 per cent in large piping. However, the lower skin friction loss occurs coincidentally with the high rate of application of wash water during the summer; and, further, skin friction is a relatively small part of the total loss in the piping, of which as much as 90 per cent may be due to eddy losses resulting from changes in velocity and direction.

Examples of Hydraulic Losses in Complete Wash Water Systems

For practical demonstration of the hydraulic losses in a complete filter washing system, tabulations and diagrams are presented showing comparative studies of alternative designs for the Meander Creek Filter Plant of the Mahoning Valley Sanitary District.

This plant consists of ten filter units of 4 M.G.D. capacity each when operating at the rate of 125 M.G.D. per acre. Two rows of five filters each are built on the roofs of the clear water wells on opposite sides of the central pipe gallery. Abutting one end of the pipe gallery is a three-story administration building, the top floor of which contains tanks for the storage of wash water.

The contract drawings for this work carried a design of perforated pipe underdrainage system, illustrated in Fig. 1.

Alternative bids on other types of underdrainage system were invited, and the plant was actually built with under drainage of the false Wheeler filter bottom type as illustrated in Figs. 2 and 3—at slightly less expense, and with improved hydraulic performance.

Losses of head in the several component parts of the two alternative systems for various rates of wash are set forth in Tables Nos. 2 and 3 illustrated in Fig. 4. The sum of the losses in gravel and sand and the head over lip of gutter does not vary importantly. Losses in the underdrain system and the piping increase with the square of the rate of wash.

Rates of wash higher than about 36 inches per minute are of no practical importance in the actual installation, but the data have been extended up to a rate of 48 inches per minute in order to illustrate the rapid building up of loss of head with increasing rates.

TABLE NO. 2
Loss of Head in Filter Washing System
(Filters Equipped with Perforated Pipe Underdrain System)

	Rate of Wash — Inches Per Minute						
	18	21	24	30	36	42	48
Strainer System	2.97	4.13	5.53	8.72	12.47	17.11	22.35
18 Inches of Gravel...	0.23	0.26	0.30	0.38	0.45	0.53	0.60
27 Inches of Sand....	2.23	2.24	2.25	2.26	2.27	2.28	2.29
Head on Lip of Gutter	0.08	0.09	0.10	0.11	0.13	0.15	0.17
Total Loss in Filter..	5.51	6.72	8.18	11.47	15.32	20.07	25.41
Individual Filter Piping	5.27	7.16	9.35	14.62	21.10	28.55	37.50
Total Loss in Unit...	10.78	13.88	17.53	26.09	36.42	48.62	62.91
Main Wash Water Piping	4.27	5.81	7.56	11.83	17.10	23.10	30.30
Total Loss from Wash Water Tank..	15.05	19.69	25.09	37.92	53.52	71.72	93.21

TABLE NO. 3
Loss of Head in Filter Washing System
(Filters Equipped with False Wheeler Filter Bottom)

	Rate of Wash — Inches Per Minute						
	18	21	24	30	36	42	48
Wheeler Bottom	1.29	1.74	2.29	3.55	5.11	6.95	9.10
12 Inches of Gravel...	0.15	0.18	0.20	0.25	0.30	0.35	0.40
27 Inches of Sand....	2.23	2.24	2.25	2.26	2.27	2.28	2.29
Head on Lip of Gutter	0.08	0.09	0.10	0.11	0.13	0.15	0.17
Total Loss in Filter..	3.75	4.25	4.84	6.17	7.81	9.73	11.96
Individual Filter Piping	2.38	3.24	4.22	6.61	9.53	12.90	16.92
Total Loss in Unit...	6.13	7.49	9.06	12.78	17.34	22.63	28.88
Main Wash Water Piping	4.60	6.25	8.15	12.75	18.40	24.90	32.70
Total Loss from Wash Water Tank..	10.73	13.74	17.21	25.53	35.74	47.53	61.58

It will be noted that the losses in the perforated pipe underdrain design are about double those for the false Wheeler bottom design, both for the underdrain system and for the piping of the individual filter. The slight difference in friction in the main wash water piping in the two cases is due to minor changes in arrangement incidental to the different designs.

Fig. 5 shows a comparison of the total hydraulic losses in the two systems, in relation to the available head between water level in the storage tanks and the elevation of the lip of wash water gutter.

In terms of practical operating performance, the saving in hydraulic losses effected by the false Wheeler filter bottom design mean the ability to employ higher rates of wash, as follows:

TABLE NO. 4
Possible Rates of Wash — Inches Per Minute

	Perforated Pipe Underdrain System	False Wheeler Filter Bottom
Wash Water Tank Full.....	33	41
Wash Water Tank Empty.....	29	36

The filter sand used has a 30 per cent size of 0.50 mm.,

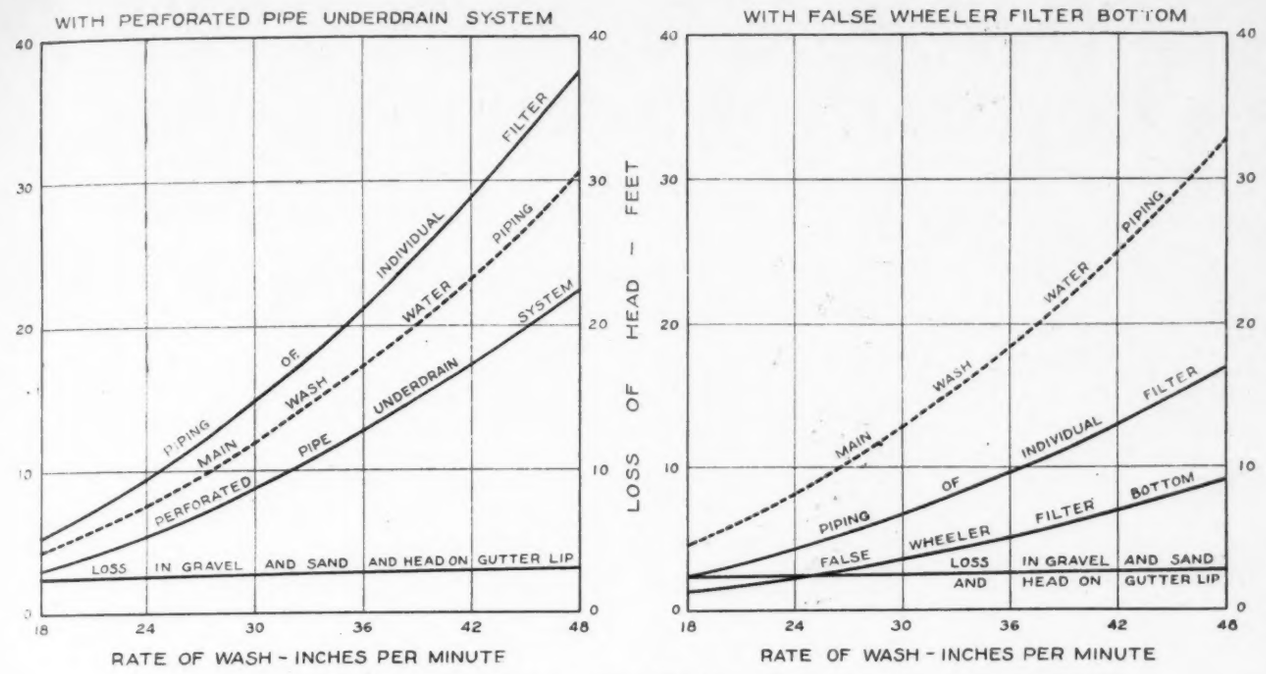

WITH PERFORATED PIPE UNDERDRAIN SYSTEM
PIPING OF MAIN WASH WATER PERFORATED PIPE UNDERDRAIN SYSTEM
INDIVIDUAL FILTER PIPING
LOSS IN GRAVEL AND SAND AND HEAD ON GUTTER LIP
RATE OF WASH - INCHES PER MINUTE
LOSS OF HEAD - FEET
WITH FALSE WHEELER FILTER BOTTOM
MAIN WASH WATER PIPING
PIPING OF FALSE WHEELER BOTTOM
INDIVIDUAL FILTER
LOSS AND HEAD ON IN GRAVEL AND SAND GUTTER LIP
RATE OF WASH - INCHES PER MINUTE

Fig. 4—Loss of Head in Various Parts of Filter Washing System for Alternative Filter Designs.

requiring a wash rate of about 29 inches per minute for 50 per cent expansion of sand bed at temperature of 70° F.

The following tabulation shows the contract cost of the false Wheeler filter bottom as actually installed, in comparison with the contractor's bid on the perforated-pipe underdrainage system:

	Perforated-Pipe Under-Drainage System	False Wheeler Filter Bottom
Bids received on 10 units of 4 M.G.D. each.		
Underdrainage system	$31,000	$45,000
Pipe connections	14,733	.....
Additional filter gravel, 9-in. thickness	2,911	.....
Total cost for 10 units	$48,644	$45,000
Cost per M.G.D. of filter capacity	$ 1,216	$ 1,125

Acknowledgment.—The above article is an amplification of a paper on the same topic which was presented by Mr. Dixon before the Ohio Conference on Water Purification.

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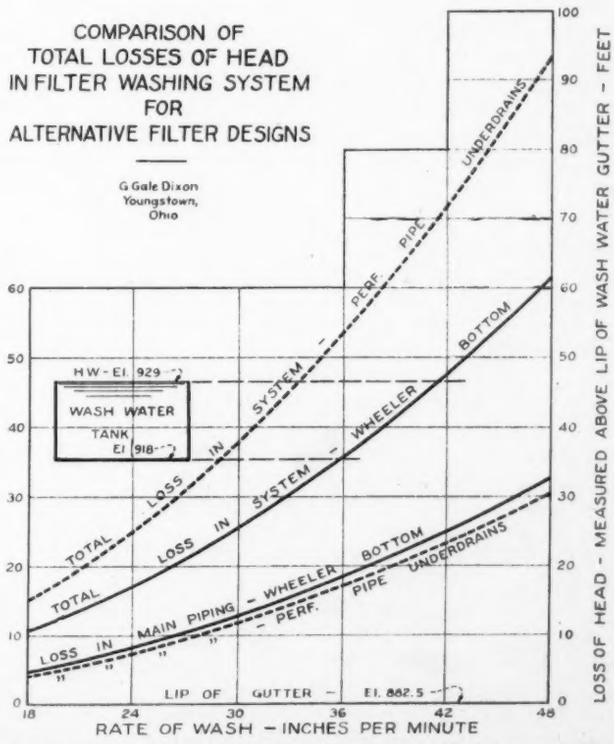
COMPARISON OF TOTAL LOSSES OF HEAD IN FILTER WASHING SYSTEM FOR ALTERNATIVE FILTER DESIGNS
G Gale Dixon Youngstown, Ohio
HW - El. 929
WASH WATER TANK El 918
TOTAL LOSS IN SYSTEM - PERF. PIPE UNDERDRAINS
TOTAL LOSS IN SYSTEM - WHEELER BOTTOM
LOSS IN MAIN PIPING - PERF. PIPE UNDERDRAINS
LOSS IN " " " - WHEELER BOTTOM
LIP OF GUTTER - El. 882.5
RATE OF WASH - INCHES PER MINUTE
LOSS OF HEAD - MEASURED ABOVE LIP OF WASH WATER GUTTER - FEET

Fig. 5—Comparing Total Losses of Head in Filter Washing System of Both Designs—Perforated Pipe vs. False Bottom.

LET'S HAVE A NEW DEAL FOR GOVERNMENT PERSONNEL!

By HARRY E. JORDAN*

President, The American Water Works Association

Harry E. Jordan

WHEN we speak of "Government" we often speak in terms of some vague, distant, abstract thing; self created; self motivating; yes, even self supporting. Of course children know better, but adult voters apparently often forget it.

Again, through the years of these United States, observers of the times have said "we are passing through times of stress and peril; the very foundations of our government are being shaken." Such expressions must be avoided in this instance. But, can we be a bit calm and consider briefly what is going on and how these events interest the water works profession?

Existing plans looking toward blending us as government and as industry into a pattern productive of reasonable security for all, with neither too much nor too little for anyone, intrigues many.

It is not the purpose of this discussion to question whether the free exercise of individualism or the fully integrated and planned industrial-governmental order produces the more rapid progress and the greater diffusion of human comforts. But, it is the purpose to point out, with all the emphasis at one's command, that neither little government nor much government will function well so long as it does not recognize the right of the governmental servant to the same well being, self respect and social security that it grants to those outside of government.

We know this—that the real steps in human forward progress resulted from the efforts of those who were long trained and skilled in their work. Some of the social values of great industrial organizations lie in the fact that devotion to the industry is rewarded by a continuing opportunity to serve that industry.

But in our whimsical devotion to the fetish of "little government" we have popularized the idea that a publicly managed service enterprise could be managed just as well in a Republican season either by a cobbler, a baker or a blacksmith—so long as he were a good Republican. And, when a Democratic victory resulted at the polls, the same municipal, state or national service could just as well be carried on by other cobblers or bakers or blacksmiths—but they *must* be Democrats. We have acted for more than a century and a half as if we believed that, but have known all the time it was not so. We acted thus more or less indiscriminatingly, whether the position in question was purely political or administrative. And, that must cease if we are to become an adult people.

It has always been true and that truth must impact itself upon our minds more forcibly than ever before, if we are to achieve any degree of success in an integration of government and industry, that administrative personnel must be chosen for their fitness to perform the duties they are called upon to exercise; that they should serve as long as their work is satisfactory and that their field of opportunity should not be confined to the one political subdivision in which they first engage themselves. In that phrase "serve as long as their work is satisfactory" many things are implied. Just as evil as political patronage is undiluted civil service. The modern expression "career service" seems more apt because it implies training, ability, security for the able—and, elimination for the inferior. Requirements of training are needed in order that, in words a water works man will understand, an iron molder cannot be handed a filter plant to operate in a city of a hundred thousand. Ability is essential for, likewise, the community procures for itself no worthy service if its water department is put in charge of a former real estate promoter. Too many water departments today are paying a price for over-promotion, from outsiders, to need a promoter for a manager.

Elimination of the inferior individual, heartless as it may seem, again is essential to safe operation of public services. The mechanism of admission to duty must carry with it the mechanism of detachment if the service is to be adequately rendered. Examinations to demonstrate fitness to continue are as essential as examinations to demonstrate fitness for appointment.

So the new deal, whatever else it may mean to any men, must mean one thing to all—administration of governmental services, especially technical services, by men who are competent, trained and interested and by men for whom the future brings as definite a picture of security as does the future of any other individual. Too long have the water department employes of this country been pawns in the political chess game. And with the record of one city of over half a million population within the past two years, having replaced nine out of every ten men in the water department for favorites of the victorious political clique, we need be under no illusion that the political chess game is a thing of the past.

One of the groups of real "forgotten men" in these United States is that group of useful and faithful public servants in the municipal water departments—servants of 80 per cent of the urban population of the country—whose willingness to devote themselves to the advancement of their work and to the safety and comfort of their communities, has been callously disregarded by the great majority of citizens who take no real interest in efficient public service, who have no interest in their water supply so long as the water flows and so long as they can drink it and it does not kill them.

The water works profession, united in a growing and more influential American Water Works Association, owes to itself and the people of all the country an awakening to its responsibility and need for greater unity, an upward struggle out of the limbo of forgotten things and the energy of the crusading spirit to fight for the proper recognition of servants of the people under the "new deal," the "old deal" or any deal that this country undertakes.

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EFFECT OF CHLORINATION ON ACTIVATED SLUDGE*

Part I.—The Effect of Complete Chlorination

By WILLEM RUDOLFS[1] and NOEL S. CHAMBERLIN[2]
New Brunswick, N. J.

IN order to throw light upon the many conflicting theories and claims regarding the activated sludge process of sewage treatment, studies have been in progress in our laboratory during the last several years. Among others, experiments were conducted to determine the effect of chlorine upon the behavior of activated sludge. The present contribution deals only with the effect of complete chlorination in connection with:

(1) The theory that activated sludge is primarily a chemical process, and;

(2) Temporary complete chlorination to control the operation of the process.

As indices of clarification and stabilization we have used primarily: turbidity, settling and B.O.D. determinations. Determinations were made on (a) activated sludge alone, (sludge coming from the aeration tank), (b) the resulting sludge of mixtures of activated sludge and sewage (mixed liquors), and; (c) the supernatant from mixtures of activated sludge and sewage—comparable to effluent.

Procedure

Sewage and sludge mixtures were chlorinated to the extent of from 0.2 to more than 1 p.p.m. residual chlorine. The materials were then aerated for a period of 6 hours with an abundance of air, so that the latter was not a limiting factor. In the third group of experiments reported, the chlorine demand was determined on the mixtures and the B.O.D. was ascertained, before and after chlorination and again after aeration, on the supernatant liquor after one hour settling. B.O.D. determinations were also made on supernatant liquor after settling and filtering. Similar determinations were made on the mixed liquors before and after chlorination and aeration. B.O.D. determinations on the activated sludge alone were made for 1, 2, 3, 4, 5, and 10 days. All materials were reseeded with 1 or 2 per cent of raw sewage. In some cases the chlorinated material was seeded immediately (within 10 minutes) when the dilutions were made, while in other cases the material was seeded with raw sewage only after 4 hours standing. All results on B.O.D. determinations were obtained from three dilutions run in duplicate.

Results

A. *Activated sludge.* Results on the B.O.D. for different periods of incubation of non-chlorinated and chlorinated activated sludge are shown in table 1 for four samples. The samples represent sludges with a low, medium and high ultimate biochemical oxygen demand. Included is also a comparison of a sludge with medium B.O.D. reseeded after 4 hours instead of after 10 minutes. The initial residual chlorine was 2 p.p.m. and these results show a definite reduction in B.O.D. in all cases, but the magnitude of the reduction varied. Although there is a definite reduction, this is not necessarily progressive. The differences between chlorinated and non-chlorinated samples are perhaps better shown in Fig. 1, where the B.O.D. in p.p.m. is plotted against time of incubation. It can be seen that neither is the reduction in p.p.pm. or in percentages determined by the magnitude of the B.O.D. of the sludge. The reduction in B.O.D. of chlorinated material depends upon (1) the character of the sludge, in respect to its source and constituents and flora and fauna; (2) the state of oxidation of the sludge—the more oxidizable matter present, the greater is the reduction. The B.O.D. reduction of a well oxidized sludge with a low demand does not increase progressively with incubation time.

B. *Mixed liquor.* B.O.D. results of chlorinated and non-chlorinated mixed liquors with and without aeration are given in table 2. Results are presented for 3 and 5 day B.O.D. values when all mixtures were chlorinated to 2 p.p.m. residual. It can be seen that chlorination may either increase or decrease the B.O.D. of the mixtures. If there was a tendency to increase or decrease

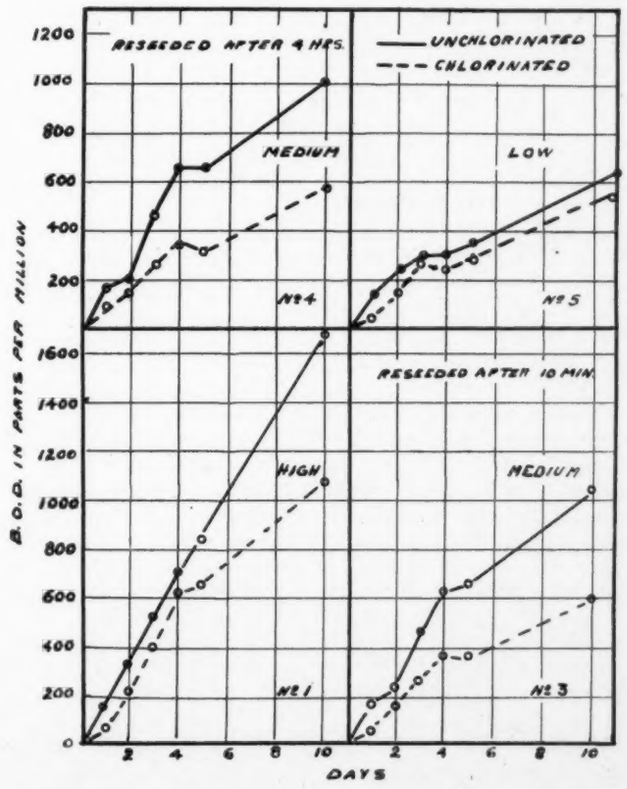

Fig. 1—Effect of chlorination on B.O.D. reduction of activated sludge

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Note—In reporting on the "Effect of Chlorination on Activated Sludge" the authors of the article have covered the subject in two parts. This, the first part, deals with "Complete Chlorination" and Part II will deal with "Partial Chlorination."

TABLE 1.—B.O.D. OF ACTIVATED SLUDGE IN (P.P.M.)—CHLORINATED VS. NON-CHLORINATED

	1—(high B.O.D.)*			3—(medium B.O.D.)*			4—(medium B.O.D.)*			5—(low B.O.D)*		
Days B.O.D.	non-chlor. ppm.	chlor. ppm.	Red. %	non-chlor. ppm.	chlor. ppm.	Red. %	non-chlor. ppm.	chlor. ppm.	Red. %	non-chlor. ppm.	chlor. ppm.	Red. %
1	150	40	73	170	60	65	175	70	60	150	60	60
2	330	225	32	230	160	30	230	150	35	240	160	33
3	520	400	23	460	260	43	480	260	46	300	280	7
4	710	620	12	620	365	41	660	350	47	305	255	16
5	840	650	22	660	360	45	645	320	49	340	330	3
10	1680	1080	35	1040	600	42	1015	580	43	...	...	..
11	...	...	..	...	...	..	...	...	..	615	540	12

*Numbers refer to graph numbers in Fig. 1.

after two days' incubation, the differences became greater after 5 days. Aeration of chlorinated mixtures may also either increase or decrease the 3 and 5 day B.O.D. There appears to be no relation between the concentration of the mixtures and the increase or decrease in B.O.D., either after chlorination alone or when the mixtures were chlorinated and aerated. The reason is that the reduction or increase depends upon the strength and character of the sewage added as well as upon the B.O.D. Further, the coagulation and purification capacity of the activated sludge has a distinct bearing.

TABLE 2.—B.O.D. OF MIXED LIQUOR (P.P.M.)

No.	Days B.O.D.	$NoCl_2$	Cl_2*	Dec.(—) or Inc.(+)	Days B.O.D.	$NoCl_2$	Cl_2*	Dec.(—) or Inc.(+)
	Before Aeration							
1...	2	350	365	+ 15	5	875	905	+ 30
2...	3	610	425	—185	5	1155	855	—300
3...	3	440	395	— 45	5	795	735	— 60
	After 6 Hours' Aeration							
4...	2	365	350	— 15	5	645	765	+120
5...	3	495	435	— 60	5	755	885	+130
6...	3	450	440	— 10	5	760	600	—160

*Chlorine dosages 57 to 81 p.p.m.—Residual 0.2 to 1.0 p.p.m.

C. *Supernatant liquor.* The results on turbidity of supernatant liquor and sludge volume of mixtures of sewage and activated sludge are given in table 3 in the order of excess chlorine added. The chlorine demand of the mixtures (contributed mostly by the sludge itself) varied from 57 to 81 p.p.m. The turbidity of the supernatant of unchlorinated mixtures was reduced from 40 to 77 per cent after 6 hours aeration. Chlorination increased the turbidity (settled material) from 34 to 105 per cent, while after 6 hours aeration the turbidity was still further increased by 40 to 140 per cent.

Aeration of the mixtures caused a reduction of from 15 to 50 per cent in the sludge volume, but the sludge volume increased considerably when the mixtures were chlorinated. The volume reduced after the chlorinated mixtures were aerated to somewhat less than that in the mixtures of unchlorinated sewage and activated sludge which had not been aerated.

The results on changes in 5 day B.O.D. of the supernatant from settled mixed activated sludge as well as settled and filtered supernatant are given in table 4. Calculating the percentages decrease caused by the aeration of the mixtures, it appears that the B.O.D. of the supernatant liquor was reduced from 69 to 90 per cent when the material was settled for one hour, and from 63 to 85 per cent when the mixtures were filtered in addition to settling. Chlorination of the mixtures caused an increase in B.O.D. of 18 to 93 per cent in the supernatant after the material had been settled and filtered. When the mixtures were aerated for six hours after chlorination an additional increase in B.O.D. from 30 to 165 per cent occurred.

Discussion

Perusal of the results will show some apparent contradictions. The B.O.D. of the activated sludge is materially reduced by chlorination, but when a mixture of sewage and activated sludge is chlorinated the B.O.D. and turbidity of the supernatant liquor increases. This in spite of the fact that the B.O.D. of sewage alone may be reduced by chlorination. Considering the results as a whole we are led to the following deductions:

Turbidity increases are due to: (1) dispersion of suspended sewage particles (floc) by the high dosages of chlorine added; (2) aeration, resulted in an additional dispersion of the sewage solids particles attacked by chlorine; (3) change in physical condition of the liquid (increased density and viscosity) was caused by greater quantities of material in suspension and solution.

Causes for the dispersion of particles may be: (1) change or reversion of electrical charge on the flocculated particles; (2) change in base exchange capacity caused by chlorination; (3) killing of organisms responsible for clotting. Theoretical consideration will be considered elsewhere at the proper time.

Sludge volume increase was caused by chlorination on account of: (1) dispersion of suspended solids which are difficult to settle; (2) swelling or expansion of the floc to which finely divided sewage solids particles adhere; (3) change in physical condition of liquor.

Sludge volume decrease of the chlorinated material is due to: (1) compacting of the floc when it lost finely divided material adhering to it; (2) change in physical condition (becoming less fluffy) and subsequent increase in specific gravity of the floc. The decrease in sludge volume after aeration was not, however, due to greater dispersion of the sewage particles, because the additional quantity of material dispersed in the supernatant liquor could only account for a fraction of the reduction in volume of the sludge.

B.O.D. increase is caused: (1) by destruction of the

TABLE 3.—TURBIDITY OF SUPERNATANT AND SLUDGE VOLUME OF MIXED ACTIVATED SLUDGE

		Res. Chlorine			Turbidity				Sludge Volume			
					Before aeration		After 6 hrs.' aeration		Before aeration		After 6 hrs.' aeration	
No.	Chlorine demand ppm.	after 10 min. ppm.	after 6 hrs. aeration ppm.	raw sewage ppm.	settled ppm.	settled chlor. ppm.	settled ppm.	settled chlor. ppm.	settled %	settled chlor. %	settled %	settled chlor. %
A	57	0.2	0	155	88	165	32	263	15	34	9	14
B	81	0.3	0	148	84	172	51	343	46	47	23	34
C	65	0.4	0	155	135	200	36	263	21	31	11	15
D	57.5	0.5	0	88	78	125	30	300	25	34	21.5	28.5
E	79	1.0	0	172	128	172	730	275	35.5	46	25	26.5
F	62.5	1.0*	0	...	...	...	36	300	..	..	..	..

TABLE 4.—B.O.D. (5-DAY) OF SUPERNATANT OF MIXED ACTIVATED SLUDGE

No.	Res. Cl_2 after 10 min. standing	B.O.D. 1 Hr. Settling				B.O.D. 1 Hr. Settling and Filtering				B.O.D. raw sewage
		Before Aeration		After 6 Hrs.' Aeration		Before Aeration		After 6 Hrs.' Aeration		
		No Cl_2	Cl_2	No Cl_2	Cl_2	No Cl_2	Cl_2	No Cl_2	Cl_2	
	ppm.	ppm.	ppm.	ppm.	ppm.	ppm.	ppm.	ppm.	ppm.	ppm.
A	0.2	114	180	19	254	80	145	14	188	223
B	0.3	76	120	24	363	57	110	21	293	...
C	0.4	145	202	17	325	98	140	16	177	215
D	0.5	83	81	22	152	56	75	15	130	...
E	1.0	83	100	21	190	58	80	12	152	...
F	1.0*	185	202	19	302	133	157	20	255	280

oxidizing, and peptizing flora and fauna; (2) by increases in soluble substances in the liquid; (3) by increases in suspended solids in the liquid. The increase in the larger suspended solids caused apparently only a small part of the increase in B.O.D. because when the material was filtered in addition to settling, a similar or greater percentage increase in B.O.D. was recorded after aeration than was found in the supernatant of the mixtures subjected to settling only. It appears therefore, that an increase in soluble solids and extremely finely divided material was mainly responsible. The fact that the quantity of extremely fine material increased, leads to the conclusion that the clotting power of the activated sludge was affected by the chlorine. If this is correct it may be said that in a sense the chlorine affected the precipitation power or the physical-chemical activity of the sludge as well as the biological activities. On the other hand, it is probable that the chlorine reacted with a portion of the soluble and finely divided substances. This is indicated in the reduction of the B.O.D. of the activated sludge alone. The reduction in B.O.D. of the activated sludge alone, and the B.O.D. reduction of sewage reported in the literature may be substantial, but conditions set up by chlorination of the sludge-sewage mixture prior to settling may produce an actual increase in the B.O.D. of the supernatant liquor. In other words an increase in the B.O.D. of the effluent may readily result if much chlorine is added to the influent of the secondary clarification tanks or is admitted to returned sludge or the aeration tanks.

As shown by Heukelekian (Sewage Works Jour. 3, 369, 1931) chlorination of mixed activated sludge affects the number of protozoa as well as the bacteria. Not all types of protozoa are affected alike, some are inactivated temporarily, some not affected at all while others are destroyed. Reseeding of the material supplied presumably a flora and fauna capable of disintegration and liquefaction of the organic matter as evidenced by the gradual increase in B.O.D., but the relation between bacteria and protozoa might very well have been materially altered by chlorination. In well oxidized activated sludge the flora and fauna are balanced, whereas in poorly oxidized material the balance may be upset. (Results on this phase of the work will be published soon.)

Insufficient information is available to show selectivity of chlorine for certain groups of bacteria or protozoa, chemical but physical factors appear also to play a role. It seems at present that *complete chlorination** is a dangerous tool in the control of the activated sludge process and that conditions of sludge and its character must be known before this tool can be effectively or safely used.

Summary and Conclusions

Mixtures of sewage and activated sludge and activated sludge alone were chlorinated to the extent of residual chlorine. Supernatant liquor of mixtures increased in turbidity and B.O.D. after chlorination and still further after aeration. The sludge volume increased after chlorination, but decreased after 6 hours aeration of the chlorinated material. Chlorination of mixed liquor may either increase or decrease the B.O.D. of the mixtures. Chlorination of the activated sludge proper reduced its B.O.D., the reduction depending upon the character of the sludge and the degree of oxidation.

The general conclusions to be drawn are:

(1) Activated sludge requires a balanced flora and fauna for maximum degree of purification and stabilization.

(2) *Complete chlorination** of activated sludge mixtures is a dangerous tool in control and affects clarification as well as oxidation or stabilization.

(3) The biochemical oxygen demand of activated sludge, alone, may be materially decreased by chlorination.

(4) Turbidity and B.O.D. of supernatant liquor or effluents may increase considerably as the result of *complete chlorination* of activated sludge-sewage mixtures, whether the chlorine be added before or after 6 hours of aeration.

*Chlorination to the point of satisfaction of the chlorine demand, wherein a trace or more of residual chlorine remains in the treated material.

A New Pipe Service

Reading Iron Company has announced recently the establishment of a Commercial Research Department, for the purpose of rendering technical advice and services to pipe users.

Realization that the many conflicting claims which have been made for different kinds of pipe have resulted in confusion detrimental, in many cases, to the best interests of the pipe buyer, prompted the Reeading Iron So. to establish this department which is manned and served by skilled technicians.

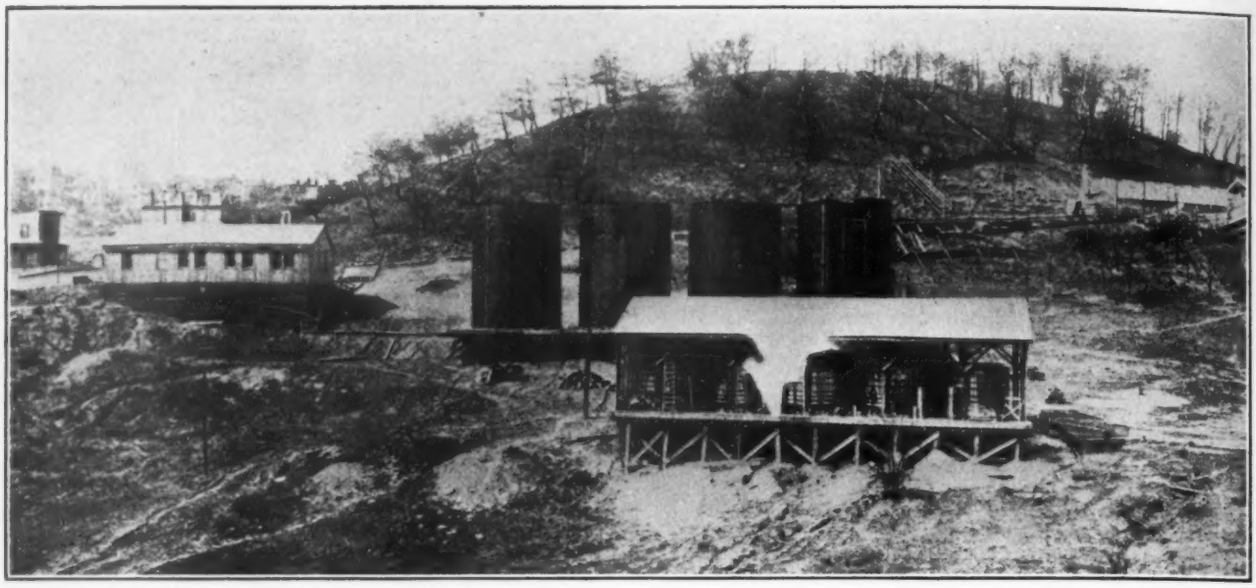
It is felt that the services to be rendered by the personnel of the new Commercial Research Department, to the man who wishes to be sure of using the right pipe in the right place, will meet a long felt need. The pipe buyer is thus to have available (without obligation) an authoritative source of information as to the relative merits of various kinds of pipe for specific uses.

The announced policy of Reading Iron Company's Commercial Research Department is to hold no brief for any particular kind of pipe. Opinions and conclusions are to be based solely upon conditions of service and established records of various kinds of pipe under the same or similar conditions.

Waste Oils from Garages Put to Good Use

In Charleston, S. C., rat infested and fly breeding dumps have been doused with mixtures of garage oil waste (10 parts) and kerosene oil (1 part). The touch of a match does the rest. The work was done under the City Health officers by unemployed negroes as a work relief measure. The job celebrated the passing of the city dumps, with the extension of incinerator installations.

At Canajoharie, N. Y., garage oil wastes are collected and utilized at the new incinerator as auxiliary fuel when needed.



General View of Experimental Plant at Cincinnati, O.—1899

REMINISCING ON THE INSTALLATION OF MECHANICAL FILTRATION

Three Decades Ago at Cincinnati

By IRA H. JEWELL
Chicago, Illinois

THE report on "Water Purification" by the late George W. Fuller, dated 1899, gives complete data covering the experimental tests conducted to determine the advisability of the use of mechanical filtration on the muddy Ohio River water.

The final recommendation at that time was to the effect that the so-called American system such as provided with the O. H. Jewell Filter No. 20, was best to employ, and cheaper to build and operate than any other scheme of filtration available at that time for turbid waters.

After these studies were made the Cincinnati Experimental Plant, here illustrated, was altered so as to test the use of excess lime treatment with both sand and polarite filters and also consisted of using carbonic acid gas (CO_2) for neutralization of the excess causticity in the water.

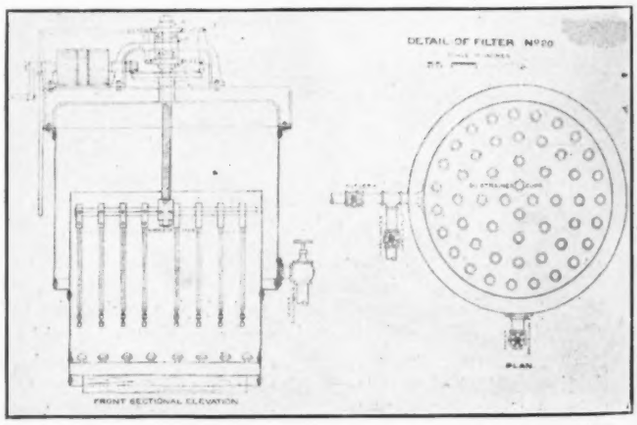
The total cost of this experimental work was $41,587.92. It was conducted under direction of the Board of Trustees' Commissioners of Water Works, of which Mr. August Herrmann was President. Mr. G. Bouscarin was Chief Engineer and G. H. Bensenberg and Charles Hermany, Assistant Engineers. Mr. George W. Fuller's principal assistants were Charles A. Parmalee, Joseph W. Ellms, and George A. Johnson.

When the filter plant was finally built and ready for operation, it was placed under the charge of Mr. Joseph W. Ellms, now Engineer of Water Purification and Sewage Disposal for the Department of Public Works, Cleveland, Ohio. He chose as his assistant in the Cincinnati plant, Mr. Clarence Bahlman, who is still there and has the position of Supervisor of Water Purification, in charge of the plant.

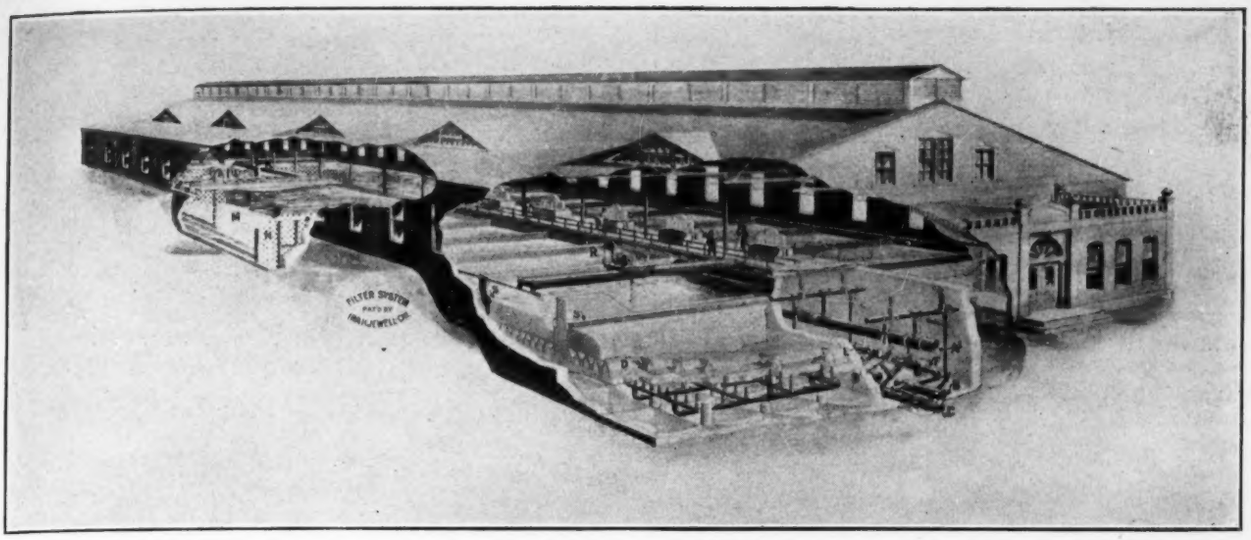
Under date of July 11, 1906, a contract was made between the Board of Trustees and the writer for license under his patents Nos. 649,409, 10, and 11, all issued May 8, 1900 (now expired), which covered the new filtration plant of which an old cut is shown here. The contract was made following the submission of a paper on "Water Works Filtration" by the writer which described these new inventions and improvements, at which time this illustration was submitted along with comments of advantages to be gained by certain new departures, instead of building a plant equipped with the circular filters, which were the best type on the market at that time.

Experiments by Ellms

While the engineers were designing the new plant (after the experimental tests of Mr. Fuller were finished), additional experiments were undertaken by Mr.



The Famous False Bottom, O. H. Jewell Filter No. 20, Put Under Test at Louisville and Later at Cincinnati in 1899



A New Departure in Filter Plant Design—1903. *Recommended for Adoption at Cincinnati by Ira H. Jewell, the Author of this Article*

Ellms, primarily concerning the best type of filter to build, which would eliminate the use of mechanical rakes as utilized in the O. H. Jewell Filter. For this purpose a wood filter was first built (later one with glass sides), for a study of the effect of increasing water rates for washing the sand, and the best type of underdrain strainer system for the purpose.

It was decided that a wire mesh screen between the underlying gravel layer and the sand bed above, to hold the gravel in place, would be the best type. These ideas were incorporated in the plant as originally built but since that time the interposed wire screen has been removed and the gravel layer made deeper.

It may be interesting at this time to give a table of the Ohio River water suspended matter in the year 1898:

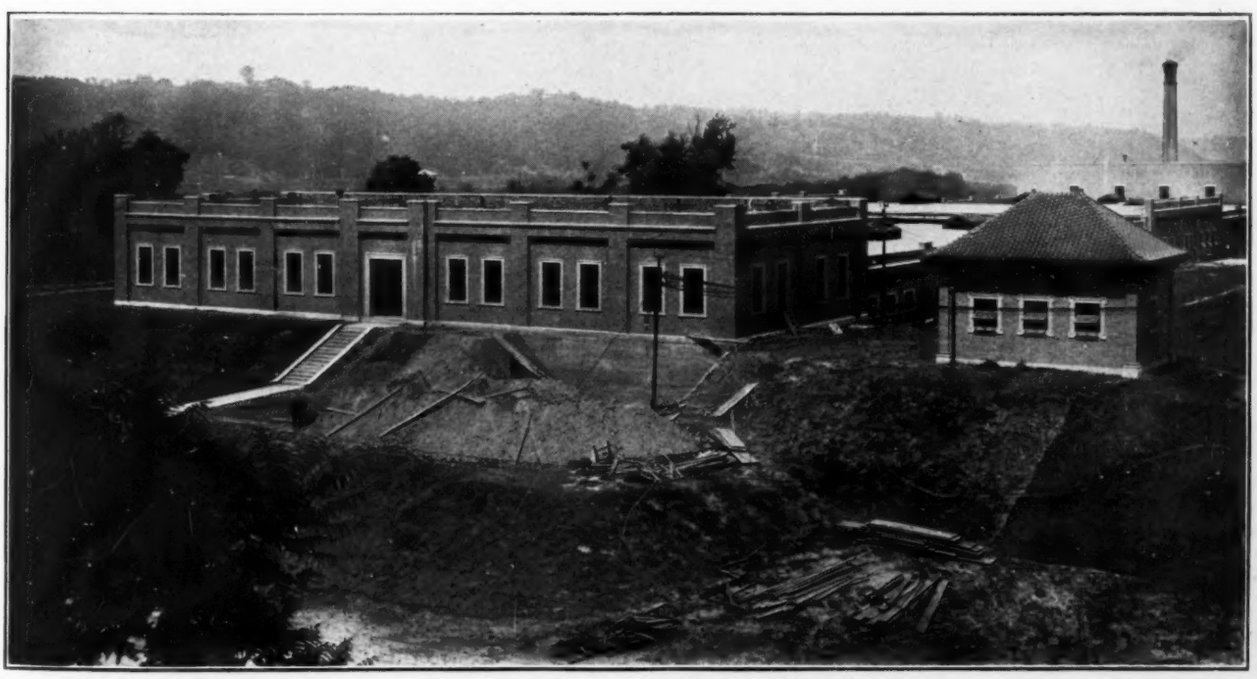
Number of Days	Corresponding Range of Suspended Matter PPM.
0	Less than 10
41	11-50
63	51-100
127	101-250
99	251-500
29	501-1000
5	1001-2000
1	Over 2000
Average	230

Doubtless many readers will be interested to know the amount of alumina sulphate (filter alum) which Mr. Fuller advocated for that water in 1898:

Turbidity PPM.	Amount of Alum (Grains per Gallon)
10	0.75
25	1.25
50	1.50
75	1.95
100	2.20
125	2.45
150	2.65
175	2.85

Design Improvements Made at Cincinnati

The improvements in the new plant consisted of operating tables and appurtenances, with pilot operation on



The Cincinnati Filtration Plant as Placed in Service in 1907 (*Geo. H. Bensenberg, Chief Engineer; J. W. Ellms, Superintendent of Filtration; Clarence Bahlman, Chemist*)

Interior View of Cincinnati Filtration Plant—1907. Note the Elimination of Hand Wheels and Valve Stands and the New Idea of Operating Panel, Which Later Become Operating Tables —a Name Which Filter Men Did Not Relish

power acting valves attached to each filter unit. Also, there was introduced an underlying gravel layer below the sand bed, held in place by a system of hopper-shaped sections. The filters were to be provided with an additional overhead sand cleaning device to remove the surface impurities and to clean the upper portions of the sand bed from above. This overhead traveling device was also intended to move over the settling basins and take away the accumulations of mud. The plant as actually built, however, was not in full conformity with the writer's recommendations and did not contain all of the items which were suggested—the engineers selecting and rejecting as they saw fit.

It was then the idea to produce high bacterial efficiency direct from the filters without sterilization, but nowadays the filter plant is relied upon for clarity and palatability of effluent and sterilization is depended upon for the important bacterial elimination.

The new Cincinnati Filtration Plant went into service about October 20, 1907, and continued to operate without sterilizing the effluent until about December 20, 1910, at which time bleaching powder was put to use (later chlorine gas), by Mr. Joseph W. Ellms, then in charge of the plant.

High Velocity Wash Developed at Cincinnati

During the "Minneapolis Litigation" Mr. Ellms testified, giving data procured at the Cincinnati plant, which pertained to sand flotation during washing, studies of washings, and type of strainer system employed, under direction of Mr. George H. Bensenberg, Chief Engineer of the new plant.

During the period of experimentation by Mr. Ellms, the writer's patents Nos. 649409-10-11 were still in effect, having been issued under date of May 8, 1900. Prior to this time I had constructed a new type of filter, with a deep gravel bed, and conducted experiments along similar lines. This filter was equipped with a hopper shaped base and accessible filter screen supported on a cast iron column. This was to form a sectional part of a large unit with the supporting columns to act as sectional distributing members for the introduction of the wash, and take off of the effluent water. The filter was filled with gravel up to the line of its angle with the sides of the tank, but finding dislodgement of the gravel during its testing, I then placed a wire screen between the sand and gravel layer, and found it operated satisfactorily. Following these experiments, the filter was taken down and shipped to the Water Works at Dennison, Ohio.

I have always felt that even better results could have been attained at the Cincinnati plant had my inventions been completely employed. Particularly did I regret the omitting of the overhead traveling mechanism for surface cleaning of the sand beds and the coagulating basins.

Four Men Honored by A. W. W. A.

Editor of Water Works & Sewerage to Receive the Diven Medal

The following announcement has been issued by the American Water Works Association concerning award of medals and conferring of honorary memberships by the Association for 1935.

The awards will be presented and membership conferred at the annual banquet of the Association while in convention at Cincinnati, O., May 9th.

John M. Diven Memorial Medal

Linn H. Enslow

For Outstanding Service to the American Water Works Association Awarded to Linn H. Enslow, Editor WATER WORKS AND SEWERAGE, *New York, N. Y.*

John M. Goodell Prize

For a Notable Contribution to the Science or Practice of Water Works Development, Awarded to Frank E. Hale, Director of Laboratories, Department of Water Supply, Gas and Electricity, New York City. For the work performed and its presentation in his paper, entitled "Pipe Corrosion Experiments, Catskill Supply, New York City," which appeared in the October, 1934, *issue of the Journal.*

Frank E. Hale

Honorary Members

The following were elected to Honorary Membership by the Board of Directors at its meeting held on January 15, 1935:
William Molis, Supt. of Water Works, Muscatine, Ia.
Dennis F. O'Brien, A. P. Smith Mfg. Co., East Orange, N. J.

▼

Lehigh Offers Modernized Courses in Sanitary Engineering

A modernized course in Sanitary Engineering, with degree of B. S., is being offered now by Lehigh University. The requirements to be met in completing the course stresses the importance of chemistry, biology and chemical engineering subjects to the present-day and future Sanitary Engineer. Emphasis in the chemical and biological phases has been the result of the increasing attention to purification of trade wastes as well as sewage and the fact that Sanitary Engineers have been, generally, inadequately grounded in these major sciences in the past.

HYDRANT DISCHARGE MEASUREMENTS AND APPLICATION TO PROBLEMS OF WATER WORKS OPERATOR

Practical Methods of Making Measurements; Computing and Applying Results; Equipment Needed

By P. S. WILSON

Consulting Engineer, Glen Ridge, N. J.

P. S. Wilson

THE measurement of the discharge or flow from fire hydrants is a common procedure for engineers engaged in testing the fire fighting capacity of a water system. The fact is frequently overlooked that such measurements may also be very usefully applied to many other vital problems with which the operator of a water supply system is regularly confronted. It is likewise not always realized that this work may be performed with but a small expense for equipment and without the need for special technical training.

Actual measurements of the flows taking place in a water distribution system may furnish extremely valuable information to the water works operator. A water distribution system is different from most of the equipment with which other business is conducted. It is buried underground and is not subject to ready inspection. The greater portion of it has not been seen for a generation or more. Its present operator has never seen most of it and almost all he knows of it is what he has been told second or third hand or what he learns from maps and records which are in many cases woefully deficient. What information he does obtain about his system is mostly history,—what it was when it was last seen, years before, not what it is now. It is on account of these conditions that actual tests and measurements are of such great value. One can theorize for a long time as to whether a certain valve is open or shut and one may even operate the valve one way or another and still not know much more than before. But if the water in proper quantity flows through that valve and evidences itself on the other side, then the question is settled and there is no more possibility for argument.

There are two principal methods of making field measurements of the flows in water distribution systems. One of these is by means of the Pitot orifice tube inserted through a corporation cock in the side of a main. Such measurements when properly applied are of inestimable value. However, a method, of making tests, which is more readily available to the average operator, involves the measurement of hydrant discharges and less time, expense, and equipment are necessary therefore. Measurements so made are not, of course, a complete substitute for Pitot measurements in the pipes, but in many cases they may suffice in themselves to answer the questions at hand. Even if they do not, they always form a valuable guide and adjunct in the making of further and more elaborate tests, if these are later found necessary.

Methods of Measuring Hydrant Discharge

Measurements of the discharge from an ordinary fire hydrant with sufficient accuracy for most practical purposes is not difficult and every water works manager or superintendent should be able and equipped to make such measurements. By the exercise of care and good judgment, results may be obtained within fairly close limits

Fig 2—Shows Two Methods of Determining Velocity of Nozzle Discharge. (Gage on Pitot tube Held in Stream and Gage, Indicating Barrel Pressure, Shows Practically Same Readings)

Fig. 1—Hydrant Pitot Tube with Gage

of accuracy. Rough and ready methods are for the most part amply sufficient, since, for the purposes usually involved, the conclusions arrived at would not be changed by a variation of five or ten per cent one way or the other in the test results. Some of the rather approximate methods to be given must be judged with this fact in mind.

The discharge from a hydrant nozzle is determined from the size or cross sectional area of the emerging stream and from the average velocity of that stream. From these two figures the discharge may readily be computed or may be directly read from tables or diagrams such as those appended to this article.

Measuring Nozzle Diameter—Observation of flow from hydrant nozzles shows that it completely fills the nozzle, as a general rule. Therefore, a simple measurement of the internal diameter of the hydrant nozzle serves to make known the diameter of the stream of water. The entrance to the nozzle from within the barrel may occasionally (particularly in some old styles of hydrants, and hydrants with independently gated nozzles) be sharp enough to cause the emerging stream to be contracted slightly below the size of the nozzle and if such an effect is noted it should be allowed for in the diameter used. The internal diameter of each nozzle used should be carefully measured to the nearest one-sixteenth of an inch. An ordinary carpenter's rule is satisfactory for this purpose.

Determining Stream Velocity—The average velocity of the emerging stream of water may be determined in either of two ways. The most common method is by the use of a hydrant Pitot tube which may be inserted into the stream and which transforms the velocity head of the stream into the equivalent pressure head and registers it on an attached pressure gage. This instrument is shown in figure 1. It consists of a hollow blade or "cutwater," shaped so that it may be thrust into the stream without unduly deflecting it. At the end of the blade is a small opening which points directly against the flowing water. The force of the stream striking into this opening creates a pressure in it which is transmitted through the hollow blade and handle to the pressure gage. The gage is an ordinary good pressure gage, except that it should be graduated to read more closely than most gages. The gage most frequently used is graduated every pound and only reads up to about fifty pounds per square inch pressure. It must be a good grade of gage to maintain its accuracy with such close reading. For some purposes it is of value to have a very low pressure gage graduated to half pounds. Sometimes the Pitot tube and the gage are held in place in the stream by a device which clamps over the outside of the nozzle. This device is not ordinarily considered necessary, however, and its use results in greater damage to the Pitot tube if struck by a stone or other object carried by the water. The edges of the blade and the small orifice into it must be kept sharp and symmetrically shaped or the accuracy of the instrument will be seriously affected.

In use the Pitot tube is held in the stream and the pressure read while the small orifice is held at the center of the stream and pointing directly against the flow. Occasionally on large nozzles it is advisable to take a rough average of the pressures across the stream at different points horizontally and vertically. In most cases the pressure at the center will be found to be practically the average. In no case should the pressure very near the edge (within about one-fourth inch) be considered.

The other method of determining the velocity of the stream, and one which has been occasionally found more convenient by the writer, consists merely in placing on one of the hydrant nozzles a cap having an ordinary pressure gage tapped into it then allow the discharge to take place through the other nozzles. Due to the free discharge from the nozzles, practically all of the pressure head remaining in the barrel during the flow is transformed into velocity head in the jets. Since that is practically the only source of velocity head in the jets, the ordinary pressure gage indicating the pressure in the barrel will read substantially the same as a gage on a Pitot tube held in a jet. This fact may be readily confirmed by trial. In this way the discharge of a hydrant may be measured with fair accuracy, without the Pitot tube, merely by the use of a pressure gage, the gage reading being used to compute the discharge in the same manner as if it were a Pitot tube reading. The same type of gage should be used for this method as described above for the Pitot tube. Any pressure gage may be used, however, the accuracy of the results depending upon the accuracy of the gage and the closeness of the graduations and readings.

Figure 2 is a photograph showing a Pitot tube with gage being held in the stream from one hydrant nozzle while a pressure gage on the other nozzle is at the same time indicating the pressure in the barrel. This illustrates the two methods of determining the velocity head of the stream. Unfortunately the photograph does not make it possible to see what the gages are reading; actually they show the same—18 pounds per square inch. In using the Pitot at low velocities, where a quarter pound makes an appreciable difference, the instrument should be held horizontally so that the pressure gage will be at the same elevation as the nozzle.

With the same accuracy of gage reading the only inaccuracies in the second method as compared with the use of the Pitot tube are in the fact that there is a slight loss of head in entering and flowing through the nozzle and in the assumption that the velocity head in the barrel at the point of pressure reading is zero. This latter assumption is justified because the velocity in the barrel is low compared to that in the jet and the pressure reading is taken opposite or above the other nozzles which are discharging. In any case, as before mentioned, trial will show that the results are in general substantially the same for both methods. If the hydrant Pitot tube is at hand, its use is best and most convenient; the availability of the other method, however, should always be borne in mind.

The pressure gage on one nozzle, of course, prevents the use of that nozzle for the discharge of water. This is not always a disadvantage, however, particularly when the hydrant is equipped with a steamer nozzle.

A fact which may readily be perceived from the foregoing is that, when measuring the velocity with a Pitot tube, readings need only be taken (except as a check) in one of several nozzles discharging simultaneously because readings in all of the nozzle streams should be practically alike.

Computation of the Flow

By the measurement of the nozzle diameter we now have obtained the diameter of the stream of water, and from the pressure gage reading we have obtained a figure which bears a known relation to the velocity of the stream. The formula for the discharge may now be readily derived from the fact that:

Discharge = (area of stream) x (average velocity)

If d = the internal diameter of the hydrant nozzle in inches, then, using the formula for the area of a circle,

the area of the stream is $\frac{3.14xd^2}{4}$ square inches. For convenience in computing, this is divided by 144—the resulting formula being $0.00545xd^2$ to obtain the area of the stream in square feet.

The pressure gage reading, in pounds per square inch, [p] is changed to feet of water head by multiplying it by 2.31. A fundamental hydraulic formula states that the velocity of the stream of water is equal to the square root of the pressure head multiplied by the square root of two times the acceleration of a falling body due to gravity. This latter [g] is a constant and is equal to 32.2 in foot and second units. Therefore:

(a) Velocity of the stream in feet per second =
$$\sqrt{2.31\times p} \times \sqrt{2\times 32.2} = 12.2\times\sqrt{p}$$
(b) Discharge in cubic feet per second =
$$0.00545\times d^2\times 12.2\times\sqrt{p} = 0.0665\times d^2\times\sqrt{p}$$
(c) Discharge in gallons per minute =
$$29.9\times d^2\times\sqrt{p}$$

The velocity of the stream of water as determined by either of the two methods described does not take into account the very low velocity of the stream around the edges where it is held back by its contact (friction) with the nozzle. To make allowance for this, as well as to allow for a possible slight contraction of the jet, it is necessary to make use of a coefficient in computing the results. This coefficient has been determined experimentally by checking hydrant flow measurements against other and more accurate means of metering the flow. The coefficient should, theoretically, be different for different hydrants, but it is sufficiently accurate for the purposes and means of measurement under discussion to use an average figure which has been found by experiment to be about correct for most cases. The figure most generally used is 0.90 and thus the formula derived above is modified as follows:

(d) Discharge in gallons per minute =
$$0.90\times 29.9\times d^2\times\sqrt{p} = 26.9\times d^2\times\sqrt{p}$$

For convenience the 26.9 may be rounded off to an even 27 without introducing an error of importance, resulting in the completed formula:

Discharge in gallons per minute =
$$27\times d^2\times\sqrt{p}$$

The Advantage of Tables and Charts

From this formula tables may be constructed in which the discharge is given for each combination of diameter of nozzle and Pitot pressure head and from which the result of the measurement may therefore be read directly without computation. A specimen is shown in Table 1. The discharges in this table are given to the nearest ten gallons per minute. Tables may be made up very conveniently to fit in field note books. For special purposes they may be abbreviated or enlarged either in range or in closeness of reading.

Another method of handling the formula is by the use of diagrams and in figure 3 a particularly convenient form is shown for such a diagram which the author has never seen in use elsewhere. In this diagram measurements horizontally from the origin or zero are proportional to the square root of the Pitot pressure head, $\sqrt{p}$, and measurements vertically are proportional to the discharge of the hydrant nozzle in gallons per minute. An inclined straight line passing through the origin then represents each value of the nozzle diameter, d. A heavy line is drawn for each size of nozzle in use using the theoretically correct value of d,—for example 2½ inches for an ordinary hose nozzle. Light lines are then drawn on the diagram below and above the first ones representing ⅛-inch undersize and oversize of each nozzle. From these three lines values for each 1/16- to ¼-inch under and over the nominal sizes may readily be read on the diagram. This covers the usual variation of the nozzles. It is to be noted that the horizontal distances on the diagram are not directly proportional to the pressures but to the square roots of the pressures. This results in uneven spacing of the figures, but by so constructing the diagram the lines representing the nozzle diameters may be drawn straight, whereas otherwise they would be curved. The uneven spacing of the pressure lines makes accurate interpolation difficult, and

TABLE 1—HYDRANT DISCHARGE

Gallons per minute = $27\ d^2\sqrt{p}$*

	Gage Reading—Hose nozzle diameter in inches [d]					
p	2 5/16	2⅜	2 7/16	2½	2 9/16	2⅝
¼	70	80	80	80	90	90
½	100	110	110	120	120	130
¾	120	130	140	150	150	160
1	140	150	160	170	180	190
1¼	160	170	180	190	200	210
1½	180	190	200	210	220	230
1¾	190	200	210	220	230	250
2	200	210	230	240	250	260
2½	230	240	250	270	280	290
3	250	260	280	290	310	320
3½	270	280	300	320	330	350
4	290	300	320	340	350	370
4½	310	320	340	360	380	390
5	320	340	360	380	400	420
5½	340	360	380	400	420	440
6	350	370	390	410	430	460
6½	370	390	410	430	450	470
7	380	400	420	450	470	490
7½	400	420	440	460	490	510
8	410	430	450	480	500	530
8½	420	440	470	490	520	540
9	430	460	480	510	530	560
9½	440	470	490	520	550	570
10	460	480	510	530	560	590
11	480	510	530	560	590	620
12	500	530	560	590	610	650
13	520	550	580	610	640	670
14	540	570	600	630	660	700
15	560	590	620	650	690	720
16	580	610	640	670	710	740
17	600	630	660	700	730	770
18	610	650	680	720	750	790
19	630	660	700	740	770	810
20	640	680	720	750	790	830
22	680	710	750	790	830	870
24	710	750	790	830	870	910
26	740	780	820	860	900	950
28	760	810	850	890	940	980
30	790	830	880	920	970	1020

*Discharges shown to nearest 10 gals. per min.

therefore enough lines are drawn on the diagram to make this unnecessary. Having made a discharge measurement this diagram is used as follows: Pick the vertical line representing the Pitot pressure reading, follow it up or down to where it crosses the line representing the actual measured internal diameter of the nozzle, estimating where that line would be if the correct one is not on the diagram. Then follow the horizontal lines to right or left and read the discharge on the vertical scale.

A careful study of the formula and the tables and diagrams leads to a number of important observations on the carrying on of this work. When the Pitot pressure reading is low, a slight difference in the reading will result in a very large percentage difference in the result, whereas at the higher pressures a half pound or even a pound does not make much difference. For instance the difference between 1 and 2 pounds per square inch makes about 40 per cent difference in the discharge while the difference between 10 and 11 pounds per

square inch makes only about 5 per cent difference. This fact is the reason for making the pressure differences in the table and diagram smaller in the lower range. It also indicates the necessity for making very careful Pitot pressure determinations in the field, particularly at low pressures. Gages should be closely graduated as before mentioned and should have at least three inch dials. On particular work they should be calibrated with a dead weight tester before and after using and corrections applied to the readings if necessary. Gages should be handled gently and with care so as to maintain their accuracy. Since they will probably not read as high as the static pressure in the mains, care should be taken when taking pressures on a closed nozzle not to subject them to too much pressure. Other gages must, of course, be provided for taking the direct main pressures.

Emphasis must be placed on the necessity for keeping the connections between the Pitot blade and the pressure gage absolutely tight. A very slight leak, in fact only a drip which in the general splashing may not be noticed, is sufficient to make the reading considerably in error. The connections should be made up tightly with wrenches and should not be loosened in order to turn the gage into a more convenient position.

It will be noted that a 1/16-inch difference in the diameter of the nozzle makes a much greater percentage difference at high discharges than at low ones. This is the opposite from the effect of the pressures. In spite of this it will usually result in greater accuracy to use as few and as small nozzles as possible in a measurement. The use of steamer nozzles is advised only on work where approximate results would be satisfactory. Further experiments may show that a slightly different coefficient should be used in computing the discharge of the larger sizes of nozzles.

Fire Flow Tests

The making of fire flow tests is the most obvious use to which hydrant flow measurements may be put. Such tests consist in the determination of what amount of water is available at a given hydrant, or at a given group of hydrants, for use by the fire department. This test is the one usually made by the engineers of the National Board of Fire Underwriters in rating a system for fire protection. So much has been written on such tests that they need be only mentioned here. Simultaneous readings are taken on as many hydrants in a group as are needed in order to develop the capacity of the system. At the same time a record is kept at an adjacent hydrant, not discharging, of the residual pressure. From a set of such readings the discharge capacity of the system at that point with any residual pressure may be known.

The residual pressure mentioned above is the pressure remaining in the mains during the time that a flow test is taking place. This pressure is determined by the readings of a pressure gage attached to a hydrant which is *not* discharging but which is located close by and, if possible, on the side opposite to the direction from which the flow is coming. The actual capacity of the distribution system at a given point is usually considered to be the discharge with the residual pressure drawn down to some stated figure. By this method the results of flow tests at different points and on different systems are made comparable. When fire engine pumpers are to be used then the maximum capacity of the system may be considered as the discharge with the residual pressure drawn down to 20 lbs. per sq. in. If reliance is placed on direct hydrant pressure for the hose streams than the residual pressure can not be drawn down nearly so low and the maximum capacity of the system at such higher residual pressures will be less. Sometimes the capacity of a system is referred to as the discharge with a drop in pressure of 20 lbs. per sq. in., in other words with a residual pressure 20 lbs. per sq. in. less than the original pressure before the hydrants were opened. This will usually be a very different figure from the capacity at 20 lbs. per sq. in. in residual pressure.

It is usually difficult or impossible to make a flow measurement at exactly the rate of discharge which will result in the residual pressure desired. It is customary, therefore, to make the measurement at some rate of discharge as near as convenient to that producing the effect desired and then to compute what the discharge would have been at the residual pressure desired. This may be done by applying the fact that the discharge is approximately proportional to the square root of the drop in pressure.

If, for example, the original pressure in the mains before opening the hydrants had been 56 lbs. per sq. in., and the residual pressure during a flow of 2680 gallons per minute had been 32 lbs. per sq. in., then the drop in pressure during that flow was 24 lbs. per sq. in. Suppose now that it were desired to know in this example what the discharge would have been with a residual pressure of 20 lbs. per sq. in. The drop in pressure in that case would have been 36 lbs. per sq. in. It is then merely necessary to multiply the measured discharge (2680 gal. per min.) by the square root of 36 (which is 6.0) and divide by the square root of 24 (which is 4.9).

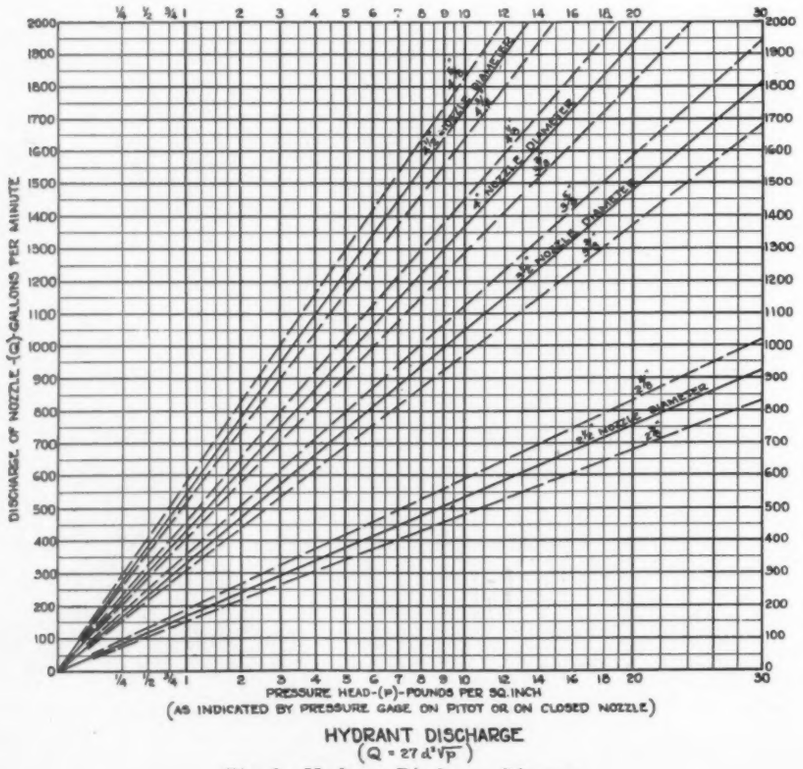

DISCHARGE OF NOZZLE-(Q)-GALLONS PER MINUTE
PRESSURE HEAD-(P)-POUNDS PER SQ. INCH
(AS INDICATED BY PRESSURE GAGE ON PITOT OR ON CLOSED NOZZLE)
HYDRANT DISCHARGE
(Q = 27 d² √p)

Fig. 3—Hydrant Discharge Diagram

$\frac{2680 \times 6.0}{4.9} = 3280$ gal. per min. which would have been the discharge at 20 lbs. per sq. in. residual pressure.

If Q_1, is the measured discharge with a drop in pressure of D_1; and, Q_2 is the discharge which would have taken place with a drop in pressure of D_2 then the above method may be stated in a general formula as follows:

$$Q_2 = Q_1 \times \frac{\sqrt{D_2}}{\sqrt{D_1}}$$

This method, as stated before, is only approximate and it should not be considered very reliable if the drop in pressure at the measured discharge is very greatly different from the drop in pressure desired. The method is, however, entirely satisfactory for most practical purposes.

Fire flow tests may indicate not only whether the system has the desired capacity or not, but they may be amplified to give information as to what work should be done to increase the capacity. For example, by taking a record of the pressures in the system during the flow test at various points progressing back toward the source of supply, it may be conclusively shown whether a restriction is in the principal supply mains or whether it is in the local mains adjacent to the test. By cutting out certain mains during the test still further information may be gained as to the actual conditions existing; closed valves or other obstructions, defective hydrants, or large leaks may be discovered and located. This work opens up a great field for the display of ingenuity on the part of the operator since the exact procedure is subject to unlimited variation and depends upon the arrangement of the particular system under test.

For further details and information regarding fire flow tests the reader is referred to a paper published in the *Journal of the American Water Works Association,* Volume 12, No. 2, October, 1924, by Mr. George W. Booth, and to other literature on the same subject.

Other Uses for Hydrant Flow Measurements

There are many other varieties of tests, measurements and experiments which may be performed on a distribution system through the use of hydrant discharge measurements. They may be used in making determinations of the friction coefficient in certain mains of the system. By isolating a stretch of pipe so that the feed into it is from one end only, a flow through it may be created which can be measured at its discharge from a hydrant or hydrants at the end of the section under test. If pressures are taken simultaneously during the flow at intermediate hydrants or other connections of known elevation along the main; then, from the data so obtained, the loss of head and the friction coefficients of each section may be computed. Obstructions or closed valves may also be located through the unequal drops in pressure in different sections along the line when such difficulties exist.

Such tests are of value in determining the necessity for or advisability of cleaning a main and in determining the effectiveness of the cleaning after it has been performed. If they are made periodically after cleaning, valuable data will be obtained as to the speed and degree of the return of roughness in the pipe, thereby indicating the true value of the cleaning and the advisability of recleaning or of cleaning other mains.

In those cases where a company's records are inaccurate, loss of head tests may be quickly made to provide an accurate indication of the size of any main which is in doubt.

When flushing out sediment or other deposits from the pipes of a system it is of great value to make a rough check of the discharge of the hydrants or blow-offs in use in order to be certain that a sufficient velocity has been created in the main or mains supplying that point to properly clean them out. From 4 to 6 feet per second is usually considered the minimum that will effectively flush out a main, so that the material remaining will cause no further difficulty by being stirred up by normal flows.

It is difficult to foresee all of the benefits which may come of making tests such as these on a distribution system. One of the greatest benefits is that, no matter what their nature, they will ordinarily result in an unusually thoughtful and detailed consideration of the system on the part of the men who are operating it. The effort to interpret and account for results, and the resulting further tests, will frequently uncover unsuspected conditions quite different from those which originally suggested the tests. Errors in maps and records, as well as definite faults in the system, are frequently discovered and therefore such tests are well worth making.

Acknowledgment—At the request of WATER WORKS AND SEWERAGE, the author has rewritten, revised and added to an article published by him in the Journal of the A. W. W. A. for July, 1930, on the same subject. We believe the practical value of the contribution justifies its re-publication.—*Editor.*

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"Cast Iron Pipe News" Makes Its Debut

(A Review)

Cast Iron Pipe News, a quarterly publication of the Cast Iron Pipe Research Association, is a brand new magazine produced as a contribution to the users and prospective users of cast-iron pipe in the Water Works and Sewerage fields. Financed by members of the Association this addition to the several publications in these fields is produced for free distribution and is supported by contributions and advertisements of manufacturers of cast-iron pipe.

The first number (January 1935) contains 24 pages carries 6 articles and many illustrations dealing with water supply and sewerage and is free of promotional matter or propaganda. *Cast Iron Pipe News* is offered as a source of special information and technical data pertaining to cast-iron pipe. Its intent is to mutually benefit users and manufacturers of cast-iron pipes. A section is devoted to human interest stories and illustrations.

For a sample copy or regular subscription (without charge) address Thomas F. Wolfe, Eng., Cast Iron Pipe Research Association, Peoples Gas Building, Chicago, Ill.

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N. G. Damoose New President, Michigan Sewage Operators' Association

At its recent meeting the Michigan Sewage Works Operators' Assn. elected N. G. Damoose, Chemist and Assistant Superintendent, Grand Rapids Sewage Treatment Works, as its new president.

R. A. Anderson of Muskegon Heights was named Vice-President and E. C. Miller (Dearborn) and W. L. Mallmann (E. Lansing) Directors. W. F. Shephard of the Michigan State Department of Health was re-elected Secretary-Treasurer.

The New Sewage Treatment Works of Bernardsville, New Jersey

MEETING OF N. J. SEWAGE WORKS ASSOCIATION

THE New Jersey Sewage Works Association celebrated its 20th birthday in annual meeting on March 21st and 22nd at Trenton, N. J.

This, the 20th Convention of the oldest American association of sewage works operators, was by every measure a successful one, with an attendance in excess of 250 and a goodly representation and exhibition by manufacturers of equipment and materials.

A resolution of appreciation was fittingly passed, thanking the Program Committee and the Committee on Arrangements, headed by P. N. Daniels, Supt. of Sewage Treatment Works at Trenton, for their work in behalf of the association. The Daniels' "speechless dinner," attended by more than 250 was, as usual, a feature of the convention.

Business Meeting

At the business meeting the following officers were re-elected for a second term:

President—W. C. Mallalieu, Boonton, N. J.
Vice-President—Edw. P. Hyland, Moorestown, N. J.
Vice-President—Edw. P. Molitor, Springfield, N. J.
Sec'y.-Editor—John R. Downes, Bound Brook, N. J.
Treasurer—Paul Molitor, Jr., Morristown, N. J.

Resolutions were passed lamenting the death of two members during the year—De Witt Vosbury, Consulting Engineer of Camden, N. J., and C. A. McDonald, former Secretary to the Chief Engineer of the State Department of Health, who had so long and well served the association as its official stenographer and reporter.

Resolutions were also passed in support of the engineers of the State Department of Health in their qualifications and capabilties, and condemning a recently published article which carried statements of a derogatory nature directed toward New Jersey authorities charged with stream pollution control.

To the defense of State Department Engineers, rose Captain Paul Molitor, Sr., who, as a veteran operator with 20 years' dealings with this group, supported them as being, both, capable sanitarians and fair to sewage works operators.

Reporting as Chairman of the Committee on Operator Licensing, C. L. Van Gill stated that only one first class plant was now operated by a man without the required license, this individual having failed on initial examination but being permitted to continue pending a re-examination. I. R. Riker brought out the fact that N. J. courts had ruled that the operator actually on duty or in daily charge must be licensed. Supervisory services (frequently too intermittent) by a licensed operator or engineer were not considered compliance with the intent of the licensing law.

W. C. Mallalieu, Supt. Sewerage Treatment, Boonton, N. J.;

Captain Paul Molitor, Sr.—Returned from Florida in Order not to Miss his 20th Consecutive Meeting.

Technical Sessions

(Pres. W. C. Mallalieu presiding.)

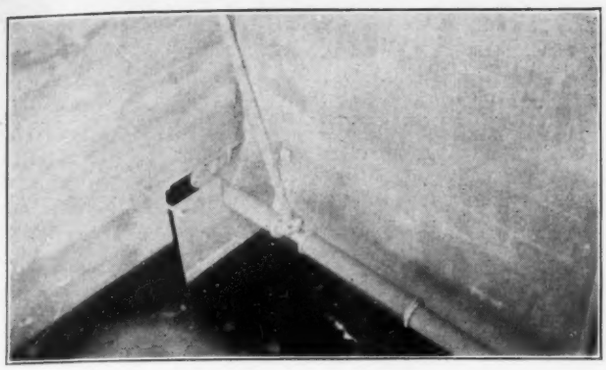
The following constitutes a digest of the high-lights of papers presented and the discussion:

"Spray Drying of Sewage Sludge"—C. L. RILEY, Industrial Associates, New York City.

Mr. Riley described the novel spray-drying sludge plant placed in service about a year ago at the Plainfield-Dunellen Sewage Treatment Works, and results attained. The paper being quite similar to that presented before the American Society of Civil Engineers in January, the reader is referred to the report which appeared on page 98 of the March issue of WATER WORKS AND SEWERAGE.

"The New Activated Sludge Plant of Bernardsville, N. J."—WESTON GAVETT, Consulting Engineer, New York City.

Mr. Gavett presented an illustrated description of the recently built activated sludge sewage treatment plant, designed by his firm (Clyde Potts, Engrs.) for Bernardsville, N. J., which was built to serve a population of 2,500 at a cost of $60,100. The plant involves presettling tanks with straight-line cleaning mechanism; 6 hr. aeration tanks (40 per cent sludge return) equipped with diffuser tubes, rather than plates, and specially cross baffled at 10 ft. intervals to preclude short circuiting (see photograph); center-feed final settling tanks (12 ft. water depth, 2.5 hr. detention) equipped with spiral sludge scrapers; 30 minute chlorination contact



Diffuser Tube and Baffling Arrangement, Bernardsville, N. J.

tank; 3 glass covered sludge beds (1 sq. ft. per capita at full load); separate digestion tanks heated) with 3 cu. ft. per capita design capacity; variable stroke plunger type sludge pumps; 3 air blowers (positive pressure type) delivering against 3.75 lbs. pressure.

Unusual features involve adoption of automatic control of return sludge, to meet sewage flow variations. Through the use of small twin ejectors, automatically timed to fill and discharge (2 min. intervals or more frequent) sludge is proportionately returned to the inlet of the aeration tanks thus improving on the use of air-lift equipment. The air diffusers, consisting of 24 inch tubes of "Aloxite" of coarse porosity (40 to 50 cu. ft. air per 24 in. tube per min.), had proved economical in air cost and otherwise satisfactory.

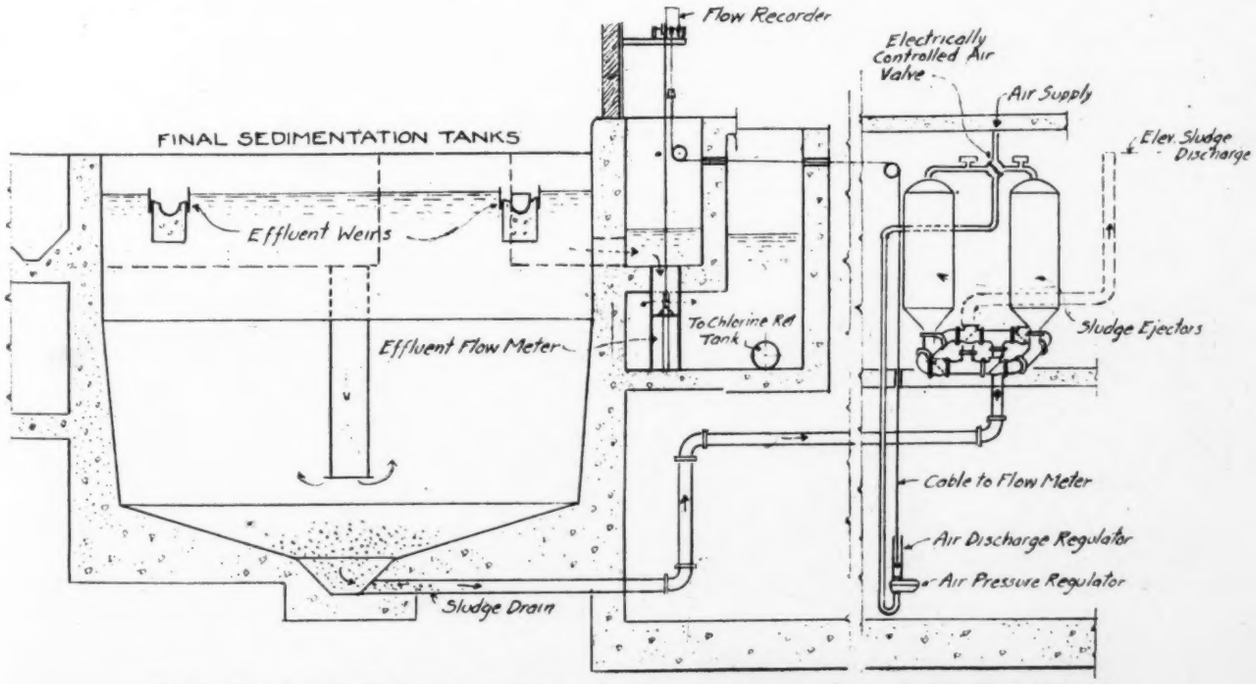
Mr. Gavett in commenting on operating results said that the cylinder and centrifuge tests had both been used in sludge measurements in operation control. The latter had proved helpful but the gravity sedimentation of mixed liquor in cylinders had been more useful. On the dry basis 1,000 p.p.m., or more, sludge appears desirable but less had given satisfactory results. Adding crude sewage to aeration tanks had been helpful to correct bulking of sludge. His opinion was that pre-settling sewage for 1 hour would prove ample. Excess sludge had been settled out with crude solids. Sludge carried in the aeration units (30 min. settling) had averaged 14.3 per cent by volume—averaging 1,000 p.p.m. dry solids. The crude B.O.D. of 196 p.p.m. had been reduced to 121 by settling and to 8.7 in the effluent. Air consumption had averaged 2.58 cu. ft. per gallon at the Bernardsville plant, the operating pressure being 3.75 lbs. per sq. in. Power used for all purposes around the plant had been on the average 119 kw. hr./day for the average flow of 91,000 gals./day.

Mr. Gavett said, that the plant operation was not difficult—two men being sufficient, because the plant could be locked up at night. He was convinced of the practicability of small activated sludge plants for location in even the best of neighborhoods. Supervision of operation during the first year, by the designing engineer, had proven its worth and such an arrangement should be mandatory when not voluntary.

"Consideration of Some Elements in the Formulation of Pollution Control of Streams"—J. K. Hoskins, Sanitary Engineer, U.S.P.H.S., Cincinnati, O.

Mr. Hoskins' paper dealt with the matter of stream pollution as a national problem, in connection with which there was in evidence a growing feeling that the federal government should establish a "Central Authority" to deal with the nation-wide cleansing of streams. He pointed out the fact that surveys had indicated that in 3,165 communities 75 per cent of the urban population of the U. S. was now being served by sewerage systems, but that only 50 per cent of the whole of the municipal sewage received treatment of some kind; and, this yielded only a 20 per cent net reduction of pollution loading of our waterways. Approximately 51 per cent of the U. S. population was concentrated in the north-central and north-east areas which amounted to only 14 per cent of the national area. Surveys had indicated industrial pollution of the Ohio River and tributaries to be 124 per cent of the domestic, and on the Mississippi 92 per cent. On the average, industrial pollution loadings of American streams equalled that of domestic municipal sewage.

Mr. Hoskins pointed to the difficulties had by municipal and state authorities in procuring treatment of industrial wastes because of threats to move the plant



Sketch of Automatic Sludge Return Scheme by Use of Ejectors at Bernardsville, N. J. (Gavett)

Weston Gavett, Consulting Engineer, New York City

Prof. H. N. Lendall, Rutgers University

into some other city or state if forced to go to the expense of waste treatment. He said that a national plan would remove this obstacle to progress in pollution abatement and had served to direct attention to the need of a central federal authority to support state or municipal authorities by formulating a national plan applicable to all states alike.

In planning remedial measures it would be advantageous to have the Central Authority set up standards of stream cleanliness and make appraisals of degree of treatment needed to evolve economic programs for particular river areas to be executed by drainage basin water-boards, state and municipal authorities. He was of the opinion that existing stream pollution bodies should be more closely consolidated or coordinated for the major purpose without duplication of effort or conflict. The handling of interstate problems would essentially be that of regional authorities handling entire river areas; whereas, purely intra-state problems would be handled by state authorities—all such work being coordinated and supported by the federal authority.

Mr. Hoskins pointed out that the Central Authority could best and most economically conduct the much needed research, evaluate or develop processes, evolve standards, disseminate information, statistics, laws. The essentiality of comprehensiveness and uniformity of measures in stream pollution correction on any national scope made it appear necessary to set up an agency with federal powers which might have the cooperation of existing state agencies in effecting the necessary co-ordination and direction in a national program.

"Experimental Work on Sedimentation"—PROF. H. N. LENDALL, Rutgers University, New Brunswick, N. J.

Offered as a progress report, covering studies undertaken to evaluate design of settling tanks and suggest features to enhance their efficiency, Dr. Lendall described an ingenious method devised by himself and his students to evaluate velocities and eddy currents set up in model tanks in which inlet, outlet and baffling arrangements could be altered at will. From the studies already completed, numerous deductions had been drawn and supported by graphs prepared to show that baffles improperly located or submerged in tanks had been more detrimental than helpful in increasing sedimentation efficiencies. In many cases it was apparent that settling tanks had served only for one-half their intended value —the first half of the tank being primarily a stilling chamber. To date, the Rutgers studies had indicated that the location of the stilling baffle 10 inches from the inlet, with a submergence of but 14 inches, had given the best index of uniformity of cross sectional velocities and displacement of the tank contents.

"Explosion Hazards in Sewers—Causes and Methods of Prevention"—E. T. KILLAM and M. H. KLEGERMAN, Associate Engrs., Alexander Potter, Cons. Engr., New York City.

Mr. Killam reviewed the increasing numbers and seriousness of explosions in municipal sewers attributed to flammable oils, gasoline, benzene and gas leakage into sewers. He also directed attention to the death from asphyxiation, gas poisoning or explosion due to sludge gas and hydrogen sulphide in sumps, tanks and sewers. As to measures of prevention of such accidents, he thought adequate ventilation of sewers more important than ever before as was the need of more attention to flushing programs. He spoke of the recent installation of vent stacks, with artificial draft, at 250 ft. intervals on a troublesome London sewer. The elimination of solids accumulations and prevention of aeration of sewage in pump wells and along sewers would serve to minimize hydrogen sulphide liberation. Rigid ordinances and the use of oil-traps would serve to keep garage oils from the sewers.

Mr. Killam felt that odor complaints indicated danger spots and these should be followed up closely, and instead of the practice of closing up vent holes in manhole-lid, more adequate ventilation should be provided. The proper use of modern detection instruments for locating dangerous spots on sewers and at treatment works was stressed by Mr. Killam. The hot wire type of flammability indicator and toxic gas indicator was now available as a combination instrument produced by the Mine Safety Appliance Company, and was being widely used by utility companies.

L. H. ENSLOW told of a scheme devised and used successfully in Houston, Tex., for tracing the discharge of oil to sewers. It consisted of "planting" a floating white painted wood block in manholes for subsequent removal by the string attached to block and top manhole step. The stain would serve to locate the branches from which the oil was entering the trunk sewer. By following up these branches the same scheme was used to trace down the offenders. Mr. Enslow also called attention to the recent availability of non-sparking chisels, hammers and other tools made of the very hard beryllium-copper alloy. He felt that every Sewer Department should have a set of these tools available for use in explosion danger zones at treatment plants, pumping stations and on the sewer proper.

Mr. Enslow also called attention to the scheme of collecting garage waste oil by some cities. At Canajahorie, N. Y., it was collected and stored at the incinerator plant for use as an auxiliary fuel supply as needed.

MORRIS COHN told of ampoules of palladium chloride put out by the Mine Safety Appliance Co. for testing

M. H. Klegerman, Alex Potter, Engrs., New York City

J. M. Potter, Penna. Salt Mfg. Co., Philadelphia, Pa.

Dr. W. Rudolfs

W. H. Baumgartner, New Brunswick, N. J.

for toxic gases. He also told of a simple scheme of venting manholes by use of a piece of stretched canvas above the ground which served as a baffle for deflecting breezes downward.

M. H. KLEGERMAN pointed out the hazard of only partially ventilating digestion tanks or sumps because, up to a point, admitting insufficient air increased explosibility of the gas-air mixture. In the case of tanks, difficult to completely ventilate, he advocated filling with water or sewage to displace all gas and thereafter emptying or pumping out of the liquid.

WESTON GAVETT in stressing the lack of respect for hazards at sewage works cited a very recent case of fire and mild explosion at the Rockville Center, L. I., works during an attempt to repair a leak into a small room from a gas pipe split by freezing. Three men were badly burned, those standing near the doorway where the gas mixture was the leanest being the more severely burned.

A member told of a close call he and two men had had in cleaning out deep spetic tanks at Asbury Park, N. J., and Dr. Rudolfs called attention to dangers from methane and carbon-dioxide gases which, by cutting down the oxygen supply, quickly caused dizziness, loss of muscular control and thereafter asphyxiation.

"Sewage Treatment Chemicals—Their Use and Abuse"—J. M. POTTER Technical Service Department, Pennsylvania Salt Mfg. Company, Philadelphia, Pa.

Mr. Potter explained that he was "pinch-hitting" for Mr. Hedgepeth, who had been scheduled to present this topic but was unavoidably prevented from attending. The illustrated talk pictured equipment and methods of handling cylinders and one ton containers of chlorine at water works and sewage treatment plants. Where containers were stored out of doors he advocated a complete industrial type fence enclosure to prevent possible tampering by boys. He described the single unit 16 ton chlorine tank cars, now in use at the larger sewage plants, and their operation. In cases where chlorinators are located on an upper floor in a building, chlorine cylinder or ton containers could with enhanced safety be connected to a manifold on the lower floor and the chlorine gas piped to the upper floor through riser pipes.

Mr. Potter discussed the characteristics of the commercially available iron coagulants comparing ferric chloride in its three available forms (anhydrous, liquid, crystal) ferric sulphate and chlorinated copperas. He pointed out that liquid ferric chloride (42 per cent Fe Cl_3) in tank car lots continued to be the most economical source of iron, provided the consumption equalled or exceeded 7 tons of iron (Fe) per year. In lesser quantity chlorinated-copperas was economical and simple to prepare. Ferric sulphate was easily handled and stored but entailed some difficulty in dissolving, requiring an agitated 30 minute detention pot beyond the dry feeder and minimum of solution water, preferably heated.

"Notes on Experimental Work of the N. J. Sewage Experimental Station"—DR. W. RUDOLFS, Chief, N. J. Sewage Exptl. Sta., Rutgers University, New Brunswick, N. J.

Dr. Rudolfs briefly touched on the studies made in connection with the activated sludge process and effects of sewage chlorination thereon. He referred to the considerable study being given to chemical precipitation methods of sewage treatment reported upon later in the meeting by Wm. H. Baumgartner (see following digest). In dewatering of sludges attention had been given to the use of accelerators and aids to ferric salts in order to cheapen the process of conditioning of sludges. Both acetine and alcohol had been helpful. Tannin when added alone had liberated 50 per cent of the water content of sludge. Passing electric current through sludges on porous plates (dialysis) had caused digested sludge to dewater to produce a cake of 46.8 per cent water content as against a 90.6 per cent cake from the control samples. After dialysis the liquid passing through the filter membrane was readily coagulable whereas it had been difficultly so otherwise. In the case of crude (raw) sludge exposed to electro ozmosis, for 15 minutes at 1.5 amps. and 22 volts, the ferric chloride required for dewatering had been reduced by 33 to 50 per cent. The results had warranted construction of a small plant for larger scale studies at the Plainfield Treatment Works.

Studies with powdered activated carbon (Nuchar) had indicated its value in assisting sludge digestion when

Seen and Heard at the Convention

L. H. Graul, Chief Operator Wildwood, N. J.
E. M. White, Supt. Sewerage Red Bank, N. J.

Wm. T. Carpenter, Chief Chemist Dept. Sanitation, N. Y. C.
J. H. Brendlin, Chemist Calco Chemical Co.

E. "A-C" Sigworth, "Nuchar" Representative
J. "E.B.G." Ferris Electro Bleaching Gas. Co. New York City

conditions of overloading existed. Where digestion had been deficient, due to poor seeding (ratio of green sludge to digested sludge too high), the addition of 6.6 gms. of carbon per liter of sludge gas production had been materially speeded up to 70 days and to 42 days with twice the carbon dosage as against 127 days in the untreated controls. In another case 115 days for peak gas production had been reduced to 35 days with 6.6 gms. per liter and 18 days with 13.2 gms. per liter. Drainability on filters or beds had been increased between 47 and 70 per cent. On well balanced digestion the beneficial effects of the carbon was much less pronounced. Dr. Rudolfs explained that all of this pointed to carbon as an excellent corrective for sludge digestion ills and plan scale studies at Princeton were under way. When adding powdered carbon to settled or crude sewage (35 lbs. per m.g.) no reduction in the oxygen demand had been noted but scum production on the surface of the settling tank had been markedly less.

In studying thermophillic digestion of sludge, it appeared that a combination of high temperature primary digestion followed by low temperature secondary digestion required only 12 to 14 days to reduce volatile matter by 85 per cent.

Robert Shaw,
Supt. Sewerage,
West Paterson, N. J.

Edwin F. Lawler,
Supt. Sewerage,
Little Falls, N. J.

Further studies of sewage chlorination had brought forth some surprising and interesting findings. Its importance as an adjunct in sewage treatment when properly employed became the more apparent. Continued agitation during the contact period following chlorine application had no worthwhile value over and above the instantaneous mixing at the point of chlorine application. Brief aeration had reduced chlorine demands considerably. The effect of chlorine on B.O.D. reduction was apparently not a function of the amount of chlorine added, for there seemed to be no common relationship between chlorine demand and B.O.D. values. He added that further studies of the many angles of sewage chlorination were to be undertaken.

In reply to a question, Dr. Rudolfs said that adding carbon to a foaming tank might make the foaming temporarily worse but the tank performance would be better in the end. The solids would separate better, leaving a cleaner supernatant.

"Results of a Survey and Study of the Performance of Sprinkling Filters"—LEROY FORMAN, Chemist, State Department of Health, Trenton, N. J.

Mr. Forman reported on an extensive study of the performance of sprinkling filters at 16 of the 34 plants in New Jersey equipped with these units—10 having trap rock; 6 having slag media and the oldest (Haddenfield) having 24 years of service to its credit. Studying the efficiencies of the 16 units it had been found that underloaded filters produced lower net purification than those handling the loadings approaching maximum of 300,000 gals. per acre foot per 24 hours allowed under New Jersey regulations. Filters with large sized media had been deficient, indicating that the 3 inch maximum allowable size of stone should be reduced. Slag filters, with 1 inch media, had been the most efficient on the whole, had not suffered media disintegration nor clogging where not seriously overloaded. Filters of more than 6 ft. depth had yielded considerably better net purification than those 6 ft. and less in depth. It seemed that nitrification was not noted in the upper 4 ft. and the 6 ft. filters converted only 55 per cent of the free ammonia against 74 per cent for the deeper units. An interesting observation was the displacement of 2 to 4 p.p.m. free ammonia from the applied sewage by nozzle aeration and splash alone. The same effect accounted for a 42 per cent reduction in carbon-dioxide, whereas 57 per cent or more was removed as the result of trickling through the filter. Allowing 42 per cent as the volume of voids in the average filter and calculating the available oxygen value of the air contained therein as against the calculated oxygen required for the purification observed, it was apparent that but little more than 1 per cent of the available oxygen within the filter had been required in the work done by the unit.

Studying the effect of the humus (solids) content of the filter discharge on the 5 day B.O.D. values, by straining samples through cheese cloth, it had been shown that the average due to such solids was but 22 per cent of the whole. The maximum was but 42 per cent. From the results of these studies a filter should be expected to turn out effluents with an average of 40 p.p.m. 5 day B.O.D. value or less, before settling out of the humus solids. During filter unloading periods (3 weeks average) final settling tanks removed but 50 per cent of the suspended solids and B.O.D. reduction was less than 20 per cent. Spring ponding and duration of unloading, with low efficiencies, could be shortened considerably by the application of chlorine or chlorinated lime without detriment to the units.

Explaining the reason for lower net purification by units at underloaded plants, Mr. Forman displayed graphs showing that for periods during the peak rates of sewage application and filter discharge the filter effluent in quality was but little different from the applied sewage. The early and late effluent from each dosing was the highly purified. This observation had been most pronounced on filters of 6 ft. or less depth, on those having the larger stone as against the 1 inch slag units and those which had poor surface distribution or rest periods several times longer than the periods of application. From these studies Mr. Forman felt that the use of small syphon tanks or other arrangements were highly desirable to produce almost continuous short cycles of application and rest. He felt that smaller media than heretofore considered acceptable could be used and with the combination of frequent, efficient distribution of applied sewage the use of shallower units would prove practicable. Thus improving the scheme of application would result in higher efficiencies of final (humus) tanks and more effective and economical chlorination.

(Note: The Chlorine Institute has for some time advocated just this arrangement which makes more practical, economical and effective the application of chlorine to the filter discharge entering the final tanks. At the same time the performance of these final tanks is materially improved and plant efficiencies raised as the result of a reduction in solids, in effluent and checking of nitrate degradation in the final tank. To this end the use

of displacement floats in syphon tanks has been used to reduce volume and increase frequency of syphon discharges.—Editor.)

Dr. W. Rudolfs in discussing Mr. Forman's paper dwelt on the little ventilation needed for trickling filters, the limitations of loadings in strength of sewages when applied too continuously, the effect of carbon dioxide and depth of units. Mr. Forman stated that very strong sewage had been satisfactorily handled on sprinkling filters at rates up to 900 gals. per min. per acre foot when efficiently distributed—requiring 9 to 10 ft. head on nozzles. He thought there was room for increasing the flexibility of dosing arrangements and spray nozzle design. He considered the revolving type of distributor a meritorious device but results from them had not been superior to the fixed nozzle where conditions were met to insure proper distribution and frequency of discharge therefrom.

"Advances of Separate Sludge Digestion and Its Relationship to Newer Trends"—Allan W. Darby, The Dorr Company, New York City.

Mr. Darby reviewed the newer developments in separate sludge digestion practices—the most recent advances being those of stage digestion, involving a primary but small heated unit followed by an unheated secondary (larger) digester. Such installations had been successful at Newark, N. Y., Peoria, Ill., and more recently at Birmingham, Ala., where chemically precipitated and crude sludge (mixed) was being thus digested. Mr. Darby pointed to the following advantages from stage digestion: (1) Reduced size of digestion capacity and first cost; (2) less heat required, thus releasing more sludge gas for power development; (3) more flexibility in sludge handling, resulting from the storage value of the unheated secondary unit; (4) gas holder built into the primary unit, thus avoiding explosion hazards and lowering cost; (5) material reduction of supernatant liquor problem resulting from greater clarity of liquor displaced only from the non-turbulent secondary unit, whereas, rapid digestion and mechanical mixing takes place in the primary unit from which the whole of its contents flow automatically to the secondary unit for separation of sludge and liquor.

Mr. Darby said that 103 activated sludge plants now employ separate sludge digestion. In addition, the following plants digested mixtures of chemical and crude sludges: Birmingham, Ala.; York, Neb.; Sioux Falls, S. D.; Cedar Rapids, Ia.; Plainfield, N. J.; Oklahoma City and others. He showed a moving picture of the new Shades Valley plant at Birmingham, Ala. (see Water Works and Sewerage, March 1935, for an illustrated article describing this plant) which employs chemical precipitation during summer months with no digestion difficulties. He stressed the nuisanceless operation and economics of the type of treatment and plant construction at Birmingham, and said he wished to direct particular attention to the future possibilities of similar plants, especially where seasonal conditions required improved plant performance at the least overall cost.

"Experimental Findings on Coagulation and Sedimentation of Sewage Solids with Iron Salts"—Wm. H. Baumgartner, Chemical Engineer, N. J. Sewage Experimental Station, New Brunswick, N. J.

Mr. Baumgartner reported on studies (principally laboratory tests involving 2 liter sewage samples) which were aimed at the evaluation of the efficacy of iron salts available for chemical precipitation of sewage and wastes. Particular attention was directed toward an evaluation of what minor dosages of iron salts would accomplish (at a moderate cost) in the way of preliminary treatment ahead of biological processes to reduce loadings on such processes during overload periods resulting from increased domestic or industrial contributions to the sewerage system.

Comparing several ferric salts, the first conclusion was that for all practical purposes the material which afforded the greatest weight of soluble ferric iron was the most desirable. Chlorinated copperas, ferric chloride and ferric sulphate had practically equal coagulating value when compared on the basis of available ferric iron content. It was considered therefore desirable to speak in terms of dosages of iron (Fe) rather than any particular salt, although chlorinated-copperas had been perhaps the most extensively used material in the tests.

Starting with minor dosages (2.5 to 15 p.p.m. Fe) the visible improvement of the treated settled sewage had not been marked but with increasing dosages up to 10 p.p.m. the increased B.O.D. reduction figures had revealed a curve of sharp incline which flattened perceptibly at 15 p.p.m. and beyond. The actual improvement was far beyond the visible improvement when sustained effective mixing was practiced, 10 to 20 minutes being essential and even longer than 20 minutes mixing giving continuity of increased efficiencies. On the whole the short rapid mix followed by the 20 minute slower mix was that which could be considered justified on practical and economic grounds and thereby proved a highly important consideration—especially so with low and moderate dosages.

C. A. Emerson, Fuller & McClintock, Engrs., New York City

D. Atkinson, City Engr., New Brunswick, N. J.

At the lower dosages (5 to 10 p.p.m. Fe) 50 to 55 per cent removal of the non-settleable B.O.D. proved to be an average attainment. At 15 to 35 p.p.m. Fe the reductions of B.O.D. rose to between 80 and 85 per cent compared to 70 or 75 per cent at dosages between 10 and 15 p.p.m. Fe. When a dosage sufficient to procure complete clarification was missed, the appearance of the effluent had suffered far more than the actual purification—a drop of considerable value in iron dosage revealing a loss of but 9 per cent in actual B.O.D. removal (73 as against 82 per cent), and but 6 per cent (89 as against 93 per cent) in suspended solids reduction. In other cases 15 p.p.m. Fe had produced a 92 per cent reduction against a 98 per cent reduction in suspended solids when 25 p.p.m. Fe had been used. Therefore, the exactness of chemical dosage control was not as important as might be assumed except that appearance of effluents would suffer where complete coagulation was in use and the dosage dropped below the optimum for such an effect. In conjunction with biological secondary treatment the appearance of the primary effluent would not be a consideration and the most economic use of chemicals would be the single criterion. On the average, iron precipitation had reduced the non settleable B.O.D. value

by 2 parts for each part of iron (Fe) added—provided effective 20 minute mixing had been given.

(Note:—The similar figure for B.O.D. reduction by chlorine, amounting to a little better than 2 parts for each part of chlorine added, is interesting. The chlorination effect, however, lacks in its ability to agglomerate and clarify sewages and its effect is largely exerted on the soluble and non-coagulable portions.—Editor.)

In reply to a question from Wellington Donaldson, Mr. Baumgartner emphasized the fact that in sludge dewatering involving low pH values ferric chloride gave superior results. In ordinary chemical precipitation where pH values of the liquid were not materially altered, one iron salt appeared to be equivalent on the whole to any other, if compared on their iron content and cost thereof. Many parallel tests had confirmed this observation before dismissing that question.

L. H. ENSLOW commented on the interesting confirmation of the fact that economy in chemical usage could be had at the expense of appearances of effluents and that would naturally lead up to the question of the practicability and economy of reduced chemical usage and provision of a filter or straining device to polish the effluent somewhat and remove additional solids and oxygen demand value. The overall result and economy from a combination of partial coagulation and biological secondary treatment or mechanical filtration of effluents would seem to possess merits which had not been sufficiently stressed. The fitting of chemical treatment into existing schemes of biological treatment would appear to have much to commend its future usage as a widely applicable adjunct to sewage treatment processes in general. Whatever method or combination of methods produced the highest effect at the least cost per unit of purification accomplished, was in the final analysis the most serviceable and practical scheme to pursue.

"Combined Disposal of Garbage and Sewage"—MORRIS M. COHN, Sanitary Engineer, Schenectady, N. Y.

The Chairman introduced Mr. Cohn as President of the New York State Sewage Work Association—the largest in America. Mr. Cohn returned the favor by acknowledging the pioneering leadership of the New Jersey Association, now 20 years old, as having been the Mecca for many years of sewerage operators and engineers seeking light on the little known subject of sewage treatment.

Mr. Cohn's paper dealt with an analysis and comparison of the similarity of the two waste products domestic garbage and sewage—and the methods of handling and disposal. Finding the per capita cost of garbage disposal so much higher than sewage disposal and realizing the ability to digest and otherwise treat garbage liquids and solids along with sewage, he advocated more consideration to such joint disposal via the sewerage system and treatment facilities.

Mr. Cohn pictured the establishment of central garbage grinding and flushing stations, to replace incinerators, and discharge of the pulped material to the sewers at scheduled hours of low loadings on the sewage works. He proposes the idea that home grinding and discharge of the house sewer will prove the preferred scheme for high class residences where such grinding equipment is affordable. He described such a device now being produced by the General Electric Company at Schenectady which has been installed in several municipalities as a test of its workability. The machine requires no more water than that for a couple of toilet flushings and would increase the sewage flow by about 1 per cent. Of the average 0.7 lbs. of garbage per capita (2200 lbs. dry solids per year per person) 15 per cent is soluble and the solids would be doubled thereby in the sewage to give a sewage comparable with European sewages in strength. The B.O.D. value of the settled sewage would be increased by 15 to 20 per cent only and he was convinced on the whole that the scheme of water carriage disposal of garbage had possibilities now which had been as unexplored as had water carriage and treatment of sewage not so many years ago.

Mr. Cohn's paper aroused considerable interest and brought forth much discussion. There was, however, some questioning as to the practicability of separating rubbish and garbage disposal, the enforcement of household grinding and sewer use, what to do with tin-cans and the like. Mr. Cohn thought that there would be little to prevent the working out of the scheme by effective ordinances and regulations and the grinding machines would be rather inexpensive to install and operate.

Exhibits Above Par

Manufacturers had exhibits which were above ordinary and deserve the whole hearted support by members of the association as was brought out by Paul Molitor, Jr., Treasurer, in his plea to members to support exhibitors and advertisers who in turn were supporting the Proceedings of the New Jersey Sewage Works Association.

The following firms exhibited:

C. G. Wrigley
The Carborundum Co.
Homelite Corp.
Fairbanks, Morse Co.
Arthur H. Thomas Co.
Chain Belt Co.
Penna. Salt Mfg. Co.
Link-Belt Co.
General Electric Co.
Chicago Pump Co.
Inertol Co.
Wailes-Dove Hermiston Co.
W. A. Taylor Co.
W. & L. E. Gurley Co.
Wallace & Tiernan Co.
The Dorr Co.
Row Engineers
Norton Co.
American Gas Products Corp.
Pacific Flush Tank Corp.
Hardinge Co.
Oliver-United Filters Co.

Association Meetings Scheduled

April 25—**Pennsylvania Water Works Operators' Association.** (Special Meeting Eastern Section.) Lancaster, Pa., at Sewage Treatment Works. Secretary I. M. Glace, State Department Health, Harrisburg, Pa.

April 27—**South Jersey Association of Water Superintendents.** Salem, N. J. Secretary, Walter Spencer, 2707 Bethel Ave., Merchantsville, N. Y.

April 29—**New England Sewage Works Association.** Hotel Continental, Cambridge, Mass. Secretary, F. W. Gilcreas, State Department of Health, Albany, N. Y.

May 6-10—Annual Convention of A. W. W. A. Hotel Netherland Plaza, Cincinnati, Ohio. Secretary, B. C. Little, 29 West 39th Street, New York, N. Y.

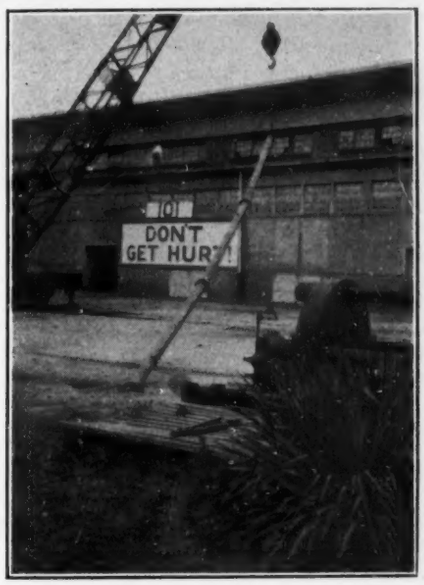
May 16-17—**Maryland-Delaware Water and Sewerage Association.** Annapolis, Md. Secretary-Treasurer, A. W. Blohm, State Department of Health, Baltimore, Md.

May 16-18—**Pacific Northwest Section A. W. W. A.** Lewiston, Idaho. Secretary, E. C. Willard, 720 Corbett Bldg., Portland, Ore.

May 17-18—**Illinois Association Sanitary Districts.** Urbana, Ill. Secretary-Treasurer, G. H. Radebaugh, Urbana, Ill.

May 24-25—**New York State Sewage Works Association.** Poughkeepsie, N. Y. Secretary, A. S. Bedell, State Department of Health, Albany, N. Y.

SOUTHEASTERN SECTION A. W. W. A. MEETS IN BIRMINGHAM, ALA.



Flexible C.I. Pipe Joints That Could "Take It" in Birmingham Demonstration. Whipped About by a Crane the Friction Joints Deflected But Failed to Part

WITH a record attendance and registration of something over 200, the Southeastern Section of the American Water Works Association held its seventh annual meeting in Birmingham, Ala., April 2nd, 3rd, and 4th.

A feature of the meeting was the day given over to a tour of inspection to the foundries of the McWane Cast Iron Pipe Co.; National Cast Iron Pipe Co.; U. S. Cast Iron Pipe Co.; American Cast Iron Pipe Co., where the members and guests were shown and explained the processes of pipe casting and finishing employed in each foundry. Also the various tests to which pipes are subjected were demonstrated as were the several types of flexible couplings used in pipe jointing. Another feature of the meeting was the inspection trip to the three new sewage treatment plants of Birmingham, with especial interest being manifested in the experimental chemical treatment plant at the Ensley plant and the full sized odorless chemical plant serving the exclusive Shades Valley district which had been previously described by H. H. Hendon, County Sanitary Engineer, and designer of the three plants. (See WATER WORKS AND SEWERAGE, March, 1935, for a description of the Shades Valley plant.)

President Jordan Addresses the Section

Following his opening address, Chairman R. E. Findlay of Macon, Ga., introduced Harry E. Jordan, President of the Association, who reviewed the part taken by the Association in the National Recovery Program, the current activities of the Association, the need for greater security of office of water works employes and the value of licensing acts in this direction. Mr. Jordan suggested that water works managers might profit from a re-study of past recommendations in Fire Underwriters' Association reports on their systems and put to good use Federal funds to make strengthening improvements and thus procure more desirable ratings inuring to the benefit of taxpayers. He also enumerated a variety of betterments which might be put in under the coming P.W.A. program.

In discussion, L. H. Enslow emphasized the need of some concerted action within the A. W. W. A. which will look toward a National scheme of old age security for water works men who, like other municipal and state employes, were being completely left out of the legislation now pending in Washington to provide pensions for retired, disabled or worn-out employes. As to security of position and tenure of office, Mr. Enslow stressed the value of water works schools and state licensing acts to prevent political interference with trained and qualified men and the displacement of faithful employes with political appointees. He cited specific cases to show the good in this direction which had come through the commission form of operation and management of water works systems, wherein ability and efficiency had been rewarded by more adequate salaries and long tenure and security of position of capable water works employes. Thus, municipal employes were put on a footing more nearly comparable to those of private water companies and he urged every water works man to seek the wresting of municipal utilities from political domination and control and the expansion of the commission management plan. Also he made a plea that the A. W.

Attending the Southeastern Section, American Water Works Association Meeting

From Left to Right: Guy White, Supt. W. W., Columbia, S. C.; W. E. Matthews III, Ala. Water Service Co., Birmingham, Ala.; Rhett Pringle, Supt. W. W., Thomasville, Ga.; A. C. Decker, Engr. I. C. & I. Ry. Co., Birmingham, Ala.; J. E. Jagger, Gen. Mgr., Ala. Water Service Co., Birmingham, Ala.; Frank W. Chapman, Supt. W. W., Greenwood, S. C.; E. O. Sweet, Engr. & Supt. Birmingham Water Co.

At Birmingham, Ala.

From Left: Flexible Joint Demonstration at National Cast Iron Pipe Plant; (2) Prindle, Ford and Bill Weir at Shades Valley Sewerage Works; (3) Paul A. Ivy, Sr. (Host), Caught in Conversation with a Visitor; (4) Paul Weir, Harry Hendon, J. W. Ivey, at Shades Valley Plant; (5) A Pipe Bursting Demonstration, U. S. Pipe & Fdy. Plant

W. A. membership be strengthened and that steps be taken by the Association to evolve some system of old age security (pensions) for faithful water works men.

Important Resolution Passed

Later in the meeting, the section passed a resolution instructing the chairman to appoint a committee to study various existing Water Works Operators' Licensing Acts with the idea of cooperating with other similar committees and the ultimate drafting of a model licensing act for consideration by the Southeastern Section for possible recommendation for adoption, with necessary minor modifications, by the states represented—S. C.; Ga.; Ala.; and Miss. Paul L. Weir, Supt. of Filtration, Atlanta, Ga., was named chairman of the committee appointed.

R. E. Findlay, Macon, Ga., Retiring Chairman

J. W. Lovejoy, Supt. W. W., Laurens, S. C., Chairman-Elect

New Officers:

Officers named for the ensuing year are:

Chairman—J. W. Lovejoy, Supt. Water Works, Lawrence, S. C.

Vice-Chairman—J. E. Jagger, Mgr., Atlanta Water Service Co., Birmingham, Ala.

Sec'y.-Treas.*—W. H. Weir, Engr., State Dept. Health, Atlanta, Ga.

Papers Presented

The following papers presented, we regret, cannot be more than listed, because of lack of space:

"Some Aspects of Interstate Carrier Water Supply Certification"—H. N. Old, Dist. Engr., U.S.P.H.S., New Orleans, La.

"Endeavors in Public Health Protection by Supervision of Water Supplies"—Geo. H. Hazelhurst, Chief Engineer, Ala., Dept. of Health, Montgomery, Ala.

Discussion—L. M. Clarkson, Chief Engr., Ga. Dept. of Health, Atlanta, Ga.; Paul L. Weir, Supt. Filtration, Atlanta, Ga.; W. D. Cates, Southeastern Underwriters, Atlanta, Ga.

"Maintenance and Operating Kinks in Water Works and Sewerage"—F. E. Stuart, Industrial Chemical Sales Company, New York City.

"Service to Municipalities Rendered by Fire Underwriters' Associations"—H. D. Cutter, Jr., Southeastern Underwriters' Assn., Atlanta, Ga.

"Business Administration of Water Works"—W. E. Matthews, Ala. Water Service Co., Birmingham, Ala.

"Elements of Sewage Treatment—With Operating and Cost Cutting Suggestions"—S. Vermilye, Supt. Sewerage, Tenafly, N. J.

"The Shades Valley Chemical Sewage Treatment Plant"—H. H. Hendon, San. Engr., Jefferson County, Birmingham, Ala.

Discussion—A. E. Griffin, Wallace & Tiernan Co., Newark, N. J.; A. C. Decker, Tenn. Coal, Iron & Railway Co., Birmingham, Ala.

L. H. Enslow, Editor, WATER WORKS AND SEWERAGE, New York.

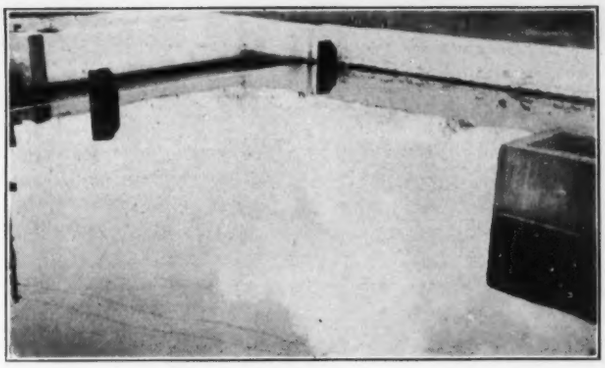
Entertainment of High Order

This report would be deficient without due acknowledgment of the excellence of the entertainment, smoker, dinner-dance, luncheon and golf tournament provided by the water works equipment manufacturers of Birmingham.

*Also a Director of the A. W. W. A. from the S. E. Section.

Snapped at Birmingham on Inspection Tour of Cast Iron Pipe Foundries

From Left: J. E. Rainwater, Supt. W. W., Cedartown, Ga.; W. A. Hansell, Chief of Construction, Atlanta, Ga.; A. R. Brown, Supt. W. W., Erwin, Tenn.; N. D. Littlejohn, Asst. Supt. W. W., Spartanburg, S. C.; H. R. Taliaferro, Ch. Engr., W. W., Macon, Ga.; M. B. Whittaker, Supt. W. W., Knoxville, Tenn.; Frank C. Crowe, Asst. Supt. W. W., Florence, Ala.



Cloud Reflections in Outlet End of Clarifier After One Hour Detention — Peachtree Demonstration Plant, Atlanta, Ga.

EVALUATION OF CHEMICAL AND OTHER METHODS OF SEWAGE TREATMENT

A Discussion of Factors to Be Considered

By ALEXANDER POTTER[1] and ELSON T. KILLAM[2]

DUE to the numerous recent developments and activities in the field of sewage treatment by chemical methods, and due to the fact that recommendations for and against this type of treatment have been identified with so many of the larger current sewerage projects in the country, the general subject of chemical treatment of sewage has received wide discussion.

Frequently these discussions have been characterized by widely contradictory claims and opinions, which obscure the fundamental issues involved. This oftentimes, seemingly, makes hopeless the task of comparing chemical treatment with other methods or a selection of the most advantageous of the several available modifications or types of chemical treatment.

It is believed that two of the most important causes of the present unusual confusion on the subject of chemical treatment are: first, the apparent wide discrepancies between records of past and recent performance; second, the tendency to regard each of the so-called proprietary processes as individually complete and different from the others, with the consequent difficulty of making a final selection.

The purpose of this article is to point out the fact that in general the wide differences between past and recent performance can be logically accounted for, and further to outline a method of approaching the problem which may tend to eliminate some of the confusion existing at the present time.

This and further discussion upon the same subject would bear on the following desirable results:

A—Prevent the cursory elimination of chemical treatment from consideration, as has frequently occurred, on the basis of prejudices resulting from past history or performances, which do not apply with facilities available today.

B—Facilitate the comparison of chemical treatment with other methods, such comparison being confined to the basically important points involved, tending toward the adoption or the rejection of chemical treatment in accordance with facts and specific local conditions.

C—The discounting of some of the "magic" frequently thrown around chemical treatment, thereby preventing its adoption in cases where this type of treatment is wholly unwarranted; and, if adopted would be largely as the result of promotional sales pressure.

Reconciliation Between Unfavorable History and Recent Creditable Performance

Recent operating results from chemical treatment schemes are far more favorable and present a distinctly different picture to that found in any of the standard volumes on sewage treatment. Accordingly, confusion naturally and instantly arises when one attempts to reconcile recent results with past performances.

Among the most common assumptions, based upon past performance, which have often led to distinct prejudices against chemical treatment, but which have been recently challenged by contradictory results, are the following:

1—That an enormous volume of sludge is produced.

2—That chemical sludge is of a particularly objectionable nature and extremely difficult to handle and dispose of.

3—That it is impossible to obtain a non-putrescible effluent from chemical treatment processes.

Large Volumes of Sludge Produced by Chemical Treatment

Large sludge volumes were inevitable in former years, due to lack of control for accurate feed and thorough mixing of the proper amount of chemicals, and due to the lack of facilities for withdrawal and concentration. The changes brought about by modern equipment for feed, mixing, and flocculation, and equipment for the prompt removal of fresh sludge, including scraping mechanisms, plunger type pumps, thickening and decantation tanks, mechanical filters and the like, as compared to conditions attending the methods formerly adopted, forms a comparison which in itself accounts for the difference in sludge quantities produced by past and present operation. The old method of decanting the entire settling basin, of scraping the sludge by hand

[1]Consulting Engineer, New York City.
[2]Associate Engineer with Alexander Potter, C. E.

with squeegees, usually aided by flushing with sewage from adjacent tanks, necessarily resulted in large sludge volumes.

Objectionable Nature and Difficulty of Handling Chemical Sludge

With reference to the second contention, namely, relative to the objectionable nature and difficulty of handling chemical sludge, recent operation of plants has afforded a basis of explanation as to why these difficulties previously occurred, and how they may be avoided with present facilities.

Perhaps the most important factor affecting the quality of chemical sludge not only from the standpoint of ready dewatering, but also from the standpoint of offensiveness, is the question of prompt handling. If sludge is promptly withdrawn from the clarifier and dewatered while in a fresh condition, then it will be found that this process can be accomplished far more effectively than with any other type of sludge. On the other hand, if the sludge is allowed to become stale, then liquefaction and putrefaction will set up and sludge both offensive and difficult to handle is the inevitable result. Whereas fresh sludge may be readily decanted and concentrated to reduce the volume, as an aid to digestion or further de-watering, this becomes impossible if the sludge is allowed to remain in the clarifier for too long a period.

The general effect of improvement of de-watering qualities by the addition of chemicals, has been particulary demonstrated during recent years in numerous plants, where conditioning with chemicals of fresh, mixed-raw and activated, and digested sludge, has been adopted in conjunction with vacuum filtration followed by artificial drying or complete incineration.

In the older plants long periods of detention and lack of facilities for removal, resulting in the withdrawal of sludge at intervals as infrequent as from one to two weeks, necessarily created a sludge of extremely poor de-watering qualities, and decidedly objectionable from an odor standpoint.

The Impossibility of Obtaining a Nonputrescible Effluent

In relation to the statement commonly found that it has been impossible, with chemical treatment, to produce a non-putrescible effluent, it may be conservatively stated that while this was undoubtedly true in the older plants, with present day facilities this limitation does not apply.

The availability of more effective chemicals at reasonable cost, equipment for control of feed at the rate required, together with mechanical equipment for thoroughly mixing the chemicals and effectively forming a flock insuring relatively complete utilization of chemicals, plays an important part in increasing plant efficiency. Facilities for the prompt removal of the precipitated sludge before liquefaction and putrefaction sets up, which would otherwise have a deleterious effect on the supernatant liquid, and therefore the effluent of the clarifier, are likewise of considerable demonstrated importance in improving efficiency. Furthermore, straining of the effluent, when necessary, brings about increased purification.

Experience gained in water supply treatment and the development of far more effective technical control, as, for instance, plant control by quickly determined pH values and optimum chemical dosages, also play an important part in increasing efficiency. While it most certainly cannot be stated that potential difficulties are not involved in the foregoing questions it can be conservatively stated that with present-day facilities, as compared with the notable lack of such facilities during earlier periods of chemical treatment, ample justification may be found for the discrepancy in inherited opinions handed down from that period and those derived from recent experiences.

Complications in the Selection of Sewage Treatment, Brought About by the Multiplicity of Processes and Methods Now Available

A second and material factor contributing to the existing confusion is the large number of proprietary chemical "processes" developed in the last few years, and the tendency to regard each as a process complete within itself, and primarily as a distinct and independent method of sewage treatment.

Until recently, the selection of the most advantageous method of sewage treatment, although involving many important considerations, was at least ordinarily limited to comparison of not more than four methods, which, for present purposes, may be designated as screening, plain sedimentation, trickling filters, and activated sludge. Furthermore, each of these methods varied so widely in both cost and efficiency that a definite choice could be readily made after an adequate study of local conditions.

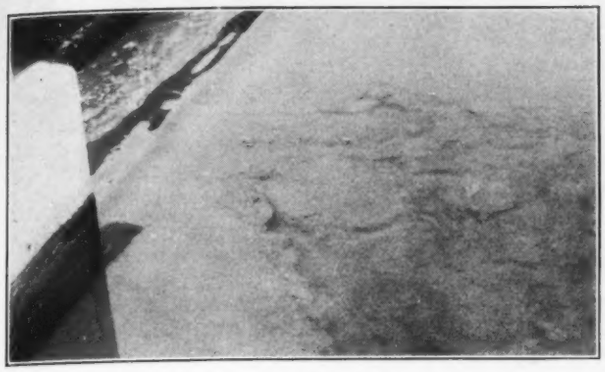
The recent addition of some 12 or 15 so-called chemical "processes" has greatly complicated the question of selection. If, as is frequently the case, each of these new processes is considered self-contained, and accordingly represents an additional type of treatment, then selection must be made of one out of 16 to 20 instead of one out of four methods.

As a further complication, operating data on each of the newer processes is very limited, and the difference in efficiency based on results to date, has been a matter of some 10 or 15 per cent one way or the other, as compared to the wide and well established difference in the efficiency of the types of treatment already in general use.

Another factor tending to complicate the selection of methods is that although the older methods involve widely different degrees of treatment, each produce a comparatively constant and established efficiency, whereas, with chemical treatment, the wide gap previously existing between primary (partial) and secondary (complete) treatment, is now filled in. Furthermore, chemical treatment, unlike the other methods, can be readily manipulated to produce varying degrees of efficiency by varying the amount of chemicals applied to the sewage.

Any attempt to generalize on a comparison between any two of the newer chemical processes, is, under present conditions, bound to be misleading. In few instances, with plants of comparable size, has the same process been used in more than one city. In still fewer instances have two processes under consideration for comparison been operated under comparable conditions in the same city. A common misapprehension is the identification of various "processes" by the kind of chemicals used, whereas, frequently the patents involve some mechanical feature or appurtenance, and the actual chemical or chemicals used have no fundamental part in the "process," but depend, or should depend, entirely upon local factors.

No one would venture to say that one particular chemical was the best for water treatment, for what is best with one type of water may prove entirely unsatisfactory with another water. Similarly, where at many plants a single chemical is found effective, at other plants, two, three, or even more chemicals in combination or at different seasons are necessary to produce effective results.



Free Chemical Treatment: An Illustration of Chemical Treatment Produced Entirely by Chemical Wastes. Perfect Floc Formation Developed by Simultaneous Discharge of Iron Bearing and Alkaline Wastes from Different Sources.

The same applies to the question of chemicals for sewage treatment. We have frequently been asked what is the best chemical for sewage treatment. Obviously, an answer requires a very considerable degree of qualification. The more important factors affecting the decision are, quality of the water supply from which the sewage originates: the nature, characteristics, and strength of the particular sewage, the degree of treatment necessary, and also the local prices of the various chemicals, which vary to a considerable degree, must prove a deciding factor if not the most important one.

As an illustration of the difficulty and unsoundness of taking results obtained in one city and expecting that they can be repeated in another, the following instance may be cited: In a recent report, chemical treatment was rejected as being too expensive, because of the fact that a certain performance obtained on the West Coast with one particular chemical, could not be duplicated here in the East. It was found that while a report of the West Coast tests showed effective results at a reasonable cost for the chemicals, in the plant in the East, three or four times as great a quantity of the chemical was required. This published opinion disregarded the fundamental point that the sewage on the West Coast had an alkalinity of some 300 parts per million, whereas, in the case of the unsuccessful attempt in the East, the alkalinity was less than one-half of this amount, and no attempt was made to raise it.

It is believed that reconcilement of recent results with past performance, the abandonment of individual consideration of the new methods as so many independent and distinct processes, together with foregoing any attempt to compare one with another, except when tried under comparable conditions, and in lieu thereof, consideration of nothing more than the fundamental factors involved, will go a long way toward the elimination of the present cross current of claims and state of confusion developed in the minds of engineers. In so doing, a clear comparison between chemical treatment and other methods may be made. Under such conditions the development of chemical treatment will advance in a proper manner and this method will be applied only where conditions are such as to render the selection justifiable.

Preliminary Comparison of Alternate Methods

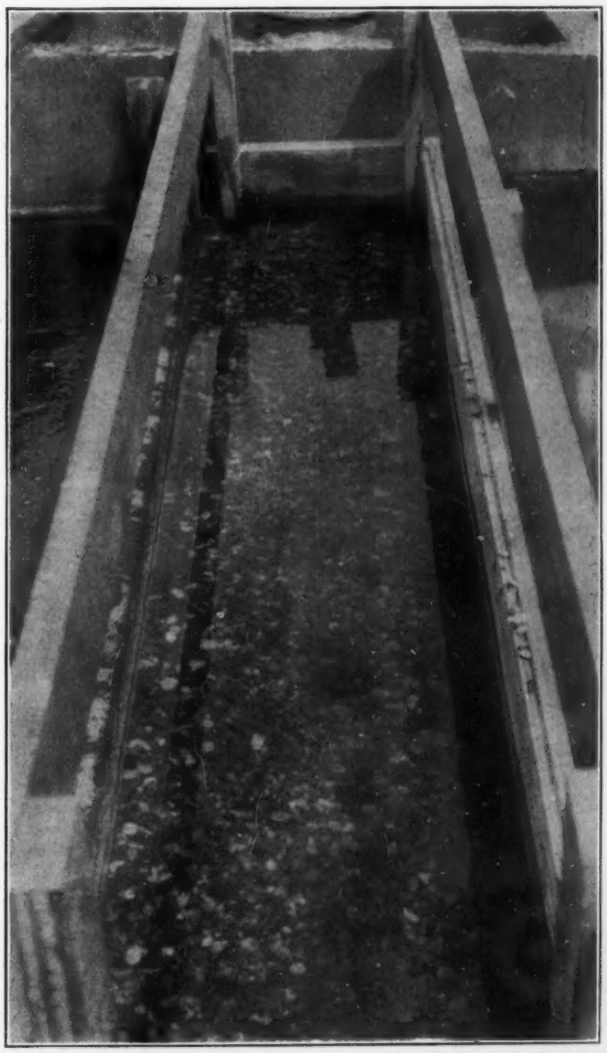
It is believed that much of the present confusion may be eliminated if consideration of available alternate methods of sewage treatment is divided into three distinct steps.

As a first step a preliminary comparison should be made between chemical treatment in its simplest form, and other methods. The conditions under which chemical treatment is likely to afford a worth-while comparison, are as follows:

1. Where the capacity of the receiving stream varies widely from month to month, due to change in stream flow and dissolved oxygen content.
2. Where seasonal requirements present a wide variation in volume to be treated or in the degree of treatment required, as in the case of shore resorts, where summer population and bathing are often important considerations.
3. Where an intermediate degree of treatment, considerably higher than plain sedimentation, but somewhat lower than other types of secondary treatment is sufficient.
4. Where the most advantageous or most economical site for the treatment plant is limited in area, or necessitates particular consideration of the odor problem.
5. Where industrial wastes are present in sufficient volume to seriously affect the operation of biological types of treatment.

Essential Elements of a Simple Chemical Type Plant

As a second step if the foregoing general considerations are found such as to justify further consideration



Peachtree Chemical Treatment Demonstration Plant, Atlanta, Ga. Effluent Passing Out of Clarifier After One Hour Detention to Produce 70-80% B. O. D. Removal. Gravel Is Six Inches Below Surface.

of chemical treatment, in comparison with other methods, then the following basic elements of a simple chemical precipitation plant may be set up and compared with other methods.

1. Screens or grit chambers, or both, should be provided, regardless of the type of treatment ultimately adopted.
2. An investigation should be made to determine the type and quantity of suitable chemical or combination of chemicals which will produce efficient precipitation with the sewage requiring treatment. A study of the quality of water supply and quality of sewage, consideration of the necessary degree of treatment, and of local cost of various available chemicals should be made.
3. Provision for chemical storage and feed, not an important item in the total plant cost, can be made.
4. Upon the basis of the chemicals tentatively selected, estimates can be made of proper mixing tanks to provide an adequate detention period and most economical chemical consumption—a highly important item to operating costs.
5. Again based upon quality of sewage and the chemicals tentatively selected, clarifiers with a proper detention period selected, can be provided. In all cases adequate scraping mechanism for prompt and efficient removal of sludge are most essential.
6. If a relatively high degree of treatment is found necessary during a substantial portion of the year, some form of "high rate filtration" or "straining" should be provided.
7. Proper provision for sludge removal and final dewatering can be determined, based upon the preceding assumptions. Whether drying on open beds, covered beds or by mechanical de-watering devices, is most advantageous, will be determined primarily by local factors.

Up to this point the structures and methods involved are not necessarily tied in with any particular "process," and the provision of screening, chemical feed and storage, mixing tanks, clarifiers, and sludge de-watering facilities, constitute all the essential structures for a going plant.

As a third step if, on the basis of the preceding assumptions, it is found that chemical treatment in its simplest form, presents a favorable comparison with alternate methods, then a more detailed consideration is warranted and various details and alternatives which involve some of the so-called proprietary "processes" may then be made.

Among the various alternatives, many of which involve patent claims, are the following:

1. In relation to the question of mixing, consideration may be given to the use of air instead of, or together with some form of mechanical stirring.
2. In connection with the provision of adequate mixing, and the most efficient use of chemicals in floc formation, flocculation in separate mixing tanks may be considered.
3. More detailed investigation may be given to various combinations of chemicals to determine the particular chemicals which will afford the most economical and effective precipitation. Consideration of this matter, except in the case of extremely large plants, may be deferred until the plant is in actual operation, at which time the plant can be tested under actual operating conditions, and the value of any special group of chemicals can be definitely demonstrated.
4. If filtration is deemed necessary, the relative cost and efficiency of various patented mechanisms, compared with the cost and efficiency of other facilities for high rate filtration may be considered.

If, in the consideration of these various alternatives definite data clearly recommends the immediate incorporation in the plant of certain patented appurtenances, equipment, or method, then such alternates may be at once included. If this is not the case, a design may, by careful planning, be made in most instances to provide for the later installation of such equipment, or for the later adoption of the specific features of some "process."

While the feeling in municipal work is ordinarily rather strongly against patented equipment and methods, this feeling is often wholly unjustified, and there can be no valid objection to the adoption, as an adjunct to a plant, of some appurtenance or method which produces a definite improvement in efficiency or reduction in cost.

In conclusion it may be stated that chemical precipitation should first be considered on the basis of the conditions required in the specific case, and upon this basis be compared with other methods. If this preliminary consideration demonstrates the justification of further consideration, then a comparison with other methods can well be made based purely on the simplest elements required for a complete and working plant, namely, screens, chemical feed and storage, mixing, clarification, and sludge digestion or immediate dewatering for land or sea disposal or incineration. Final selection of the method then becomes more a matter of detailed selection of various alternates to obtain the greatest refinement in efficiency and the lowest cost, under the specific conditions obtaining at the particular plant under consideration.

High rate filtration of effluent (straining), represents a valuable adjunct particularly where relatively complete treatment is required a greater part of the time. The cost of this item may be balanced against the cost of providing longer detention periods, and against the cost of the additional amount of chemicals required to produce the clarification and reduction of oxygen demand values without filtration.

In the last analysis, any comparison between two methods must be based not only on construction and operating cost, but upon the relative degree of treatment obtained, as compared to the actual degree of treatment required.

It can be further said that there is no single "best" method of chemical sewage treatment. Even as Nature's dilution "method" and the activated sludge process (representing the two extremes) each have their proper place in the field of sewage treatment—so will a simple type of chemical treatment find warranted application, and so may the more efficient of the various new "Chemical Processes" each be found to fit particular applications.

Flexibility is properly becoming a key-note in both water and sewage treatment plant design, and although, in a sense, the rapid development of many new methods makes the problem of selection more complicated, this condition, at the same time, broadens the field of those charged with the responsibility of the design and operation of sewage treatment plants. Accordingly, these new developments, represent a valuable asset in making possible a more effective and economical sewage treatment plan.

The foregoing discussions have been based in a large measure upon the operation of two test plants installed for the purpose of studying the cost and efficiency of various types of chemical treatment. During a portion of the period in which these plants were operated, the trials involved various patented processes, but during other portions of the tests non-patentable methods, procedure and equipment were likewise investigated in reaching a final evaluation of chemical sewage treatment in general.

MILLION GALLON STORAGE TANK PROJECT COMPLETED BY DALLAS

Is Second Elevated Tank of Its Size Erected in Texas

By JOHN B. WINDER*
Supt. Water Works and Sewerage, Dallas Texas

John B. Winder

WHEN the City of Dallas annexed the Broadmoor area in 1930 the Dallas City Waterworks was immediately confronted with the problem of supplying sufficient water under adequate pressure for domestic and fire fighting purposes.

Trinity Heights, a portion of the above area, had been rapidly built up with modest homes, scattered over a wide area. The water supply, from a well originally put down by the real estate developers, was barely able to cope with the demands made upon it. This was due primarily to two reasons; first, inadequate pressure, and second, high head losses through considerable lengths of two and four inch distribution mains.

Shortly after the annexation of the Trinity Heights area, the water system of this territory was connected to the mains of the Dallas system fed by the pumps in the Lancaster pumping station which provided the water supply for the entire Oak Cliff district. The Lancaster station, together with a small standpipe storage capacity, is located at considerable distance from the annexed territory. Due to the small mains it was impossible to distribute adequate quantities of water and maintain pressures throughout the territory which was being rapidly developed.

By 1930, new construction had made it imperative to divide the water system in the Oak Cliff district into two distinct divisions—the so-called low level district and the high level district. With the construction of the Sunset Pumping Station in the high level district, the water system in the Trinity Heights and Broadmoor area was supplied from this station.

Conditions, not easily controlled, necessitated the location of the Sunset Pumping Station and a small standpipe adjacent to one edge of the rapidly developing Trinity Heights and Broadmoor area. As the demand for water from this area increased the supply problem became increasingly acute. It became impossible, in fact, due to the small mains in this area, to maintain satisfactory pressures and distribute adequate quantities of water throughout the territory.

Seriousness of Situation

The seriousness of lack of water supply may be judged by the fact that during the summer of 1934, during the morning and evening peaks, it was even impossible for many consumers in the Trinity Heights and Broadmoor areas to draw drinking water from their taps. Water pressure available for fire protection varied over a range from 0 to 47 pounds per square inch during the summer period. The curves shown in Figure 1, marked respectively 11-26-34, 11-28-34, and 11-27-34, show typical gauge pressures on fire hydrants at three locations over twenty-four hour periods during November, 1934, when water demands are normally at a minimum.

Plans for Correction

Having adequate pump capacity already available at the Sunset Pumping Station, two plans were considered whereby adequate water could be supplied throughout the territory. The first was that of relaying the distribution mains with larger pipe; the second, that of erecting sufficient elevated storage tank capacity in the approximate center of Trinity Heights and Broadmoor areas to insure adequate pressures throughout the area at all hours. The storage tank was to be supplied through a new sixteen inch main with the excess water pumped by the Sunset Station. By means of elevated storage floating on the system the tank supply would alternately be filling or discharging, depending upon the demand.

The first thought of installing larger distribution mains proved to be non-feasible, due to the cost. Calculations showed that the second plan, involving the adaptation of an elevated tank, would adequately meet the situation. This was the solution decided upon and recently carried to completion.

Some Features of the Tank Selected

The one million gallon storage tank of a pleasing appearance is here illustrated.

New 1,000,000 Gal. Torroidal Bottom Tank at Dallas, Texas. A PWA Project, Giving Employment and Low Pressure Relief, Resulting in Decreased Complaints and Increased Revenues.

*Mr. Winder is chairman of the Maintenance and Operating Division of the A. W. W. A.; a past-president of the Southwest Water Works Ass'n, and now chairman of the new S. W. Section, A. W. W. A.—Editor.

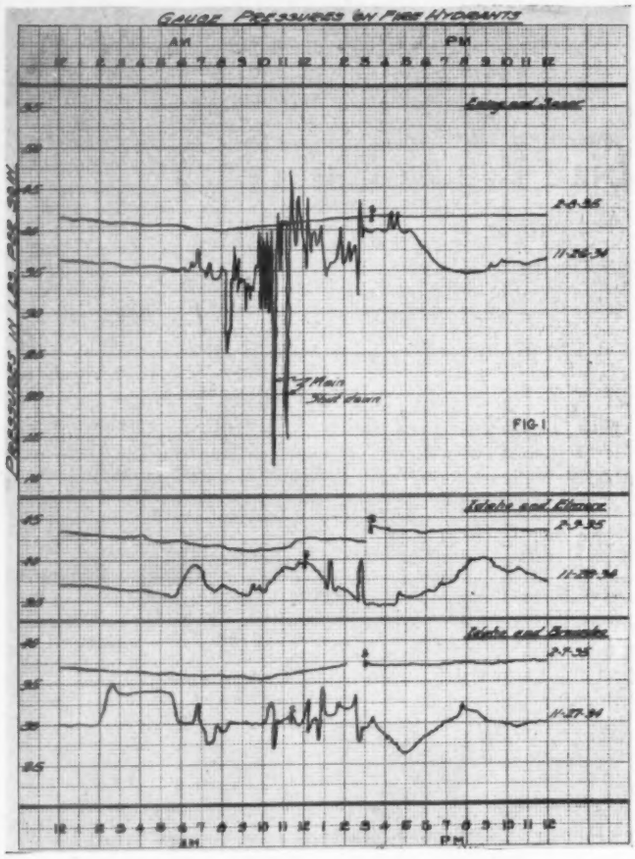


Fig. 1—Graphic Records of Pressures Before ('34) and Since ('35) Tank Installation Near Center of Trinity Heights Area, Dallas, Texas.

The tank is designed as a Torroidal Bottom Elevated Tank, the first of its kind erected in the southwest. The design of this tank combines the principle of the suspended bottom for the outer circle of bottom plates, which are dished to a comparatively large radius, with a central circular portion of continuous plate. It is of riveted construction, supported by deck beams, radial girders and internal columns. The contour of the tank is simple and the cross section is uniform. The distance from the ground line to the bottom of the bowl is 71 feet while the distance from the ground line to the maximum water line is 106 feet, which allows for 35 feet as the head range for the entire million gallon capacity. The diameter is 71 feet.

Results Procured

Since placing this tank in service the water pressures in the areas relieved have been adequate at all times for domestic service and fire protection as shown by the pressure curves on Fig. 1, marked respectively 2-8-35, 2-9-35, and 2-7-35. As a result of the increased pressures, and an adequate supply being available at all hours, water consumption has materially increased which naturally results in an attractive increased revenue to the Water Department.

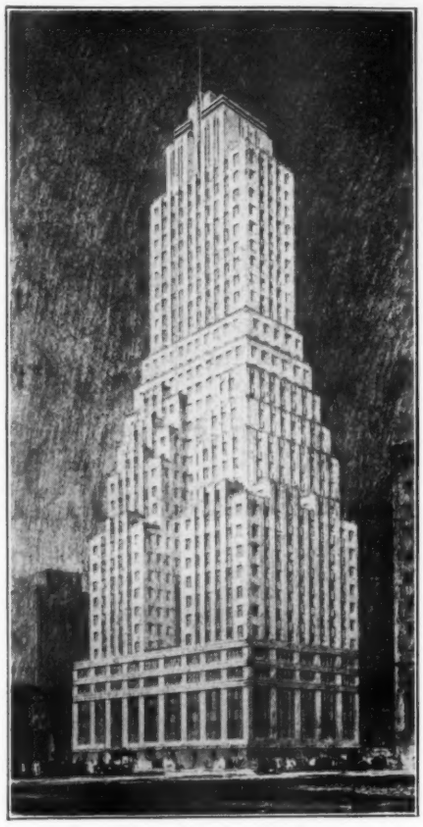
From an operating standpoint, the electrically driven pumps operate against a more nearly uniform head over the entire twenty-four hour period and this has resulted in reduced power costs due to the larger power bill discounts received as a result of the increased load factor.

This much needed project was financed through the PWA. The tank was erected by the Pittsburgh Des Moines Steel Co. at a cost of $57,800.00.

We Move New York Office

Address after May 1st, Commerce Bldg., 155 E. 44th St., New York City.

Into the above building the Editorial Office of WATER WORKS AND SEWERAGE and the business office of all



Building of Commerce

Gillette publications located in New York City, will move. The new quarters are twice the size of those now occupied and within 1 block of the Grand Central Station, making it convenient to our visitors.

Please note the new address—155 E. 44th Street.

▼

15 Ohio Municipalities to Have New Water Purification Plants

Water Softening (Lime-Soda)	Water Softening (Zeolitic Process)	Filtration and (Iron Removal)
Canal-Winchester	*Grove City	*Ashville (N)
Hamilton	*Plymouth	*Richwood (N)
Grafton	*Worthington	Fairport (N)
Leesburg	Elmore	
Mt. Sterling	New Philadelphia	
Reading		
Wooster		

*Iron removal by aeration and filtration are important features of the treatment provided.

(N) Municipalities being provided with complete new water works systems.

(Note)—Plants at Elmore, Plymouth and Reading have been completed recently.

Of the 15 plants all but 4 have been financed through PWA. When all are completed Ohio will have 58 water softening plants, 20 iron removal plants, and 58 plain filtration plants. Water softening and iron removal is rapidly spreading in Ohio and is indicative of demands for water of a more satisfactory quality for domestic usage.

A Case of High Grade Effluent from Sewage Treatment Works (on Right), Entering Industrially Polluted Stream (Left). A Far Too Frequent Condition

THE TREATMENT OF "BEER SLOP" AND SIMILAR WASTES

By A. M. BUSWELL, Ph. D.*

Chief of State Water Survey, Urbana, Ill.

THE wastes from breweries and distilleries, commonly referred to as "beer-slop," are typical of a rather large group of industrial wastes for which a common method of treatment is in general applicable. In this group we would include wastes from breweries, distilleries, grain vinegar, cereal beverages (ovaltine), starch manufacture, creameries, meat packing, citrus fruit juice, pea, bean and corn canneries, and beet sugar; in short most of the industries which produce food and drink in a "ready to use" condition.

Nearly all of these industries use water for three purposes, (a) process water, which is relatively small in amount but when discharged carries several per cent of organic matter; (b) wash water used to clean equipment, floors, etc., which is variable in quantity and may be of the approximate concentration of domestic sewage; and, (c) cooling or condenser water which is usually several time the volume of (a) and (b) but with proper piping it may be discharged in an uncontaminated condition.

This paper deals primarily with the treatment of "process water" or more properly "process by-product" in the case of certain industries such as creameries and citrus fruit juice bottlers. In the treatment proposed it is assumed that this concentrated waste (a) can be separated completely from (c) and more or less completely from the more dilute liquids composing the wash water (b).

The concentration (1, 3, 6, 7, 8) of these process liquors as shown in the tables below range from 1 per cent to 6 or 7 per cent total solids, of which the major portion is organic matter in true solution. The inorganic matter (ash) and settleable solids run considerably under 50 per cent of the total, and the oxygen consuming substances are almost wholly in solution.

With material of this sort the usual expedient of sedimentation produces relatively little improvement. The addition of chemical coagulents is likewise of limited benefit as far as oxygen demand reduction is concerned. The reason for this failure is apparent when we stop to consider that much of the organic matter in these wastes is in a state of true solution (i.e., like a salt solution or a sugar solution) and cannot be removed by coagulation. In this respect they differ from domestic sewage, for it has recently been shown[9] that passage through an "ultra filter" (i.e., a filter which will remove true colloids) will reduce the B. O. D. of ordinary sewage to zero. Substances in true solution are not removed by "ultra filtration."

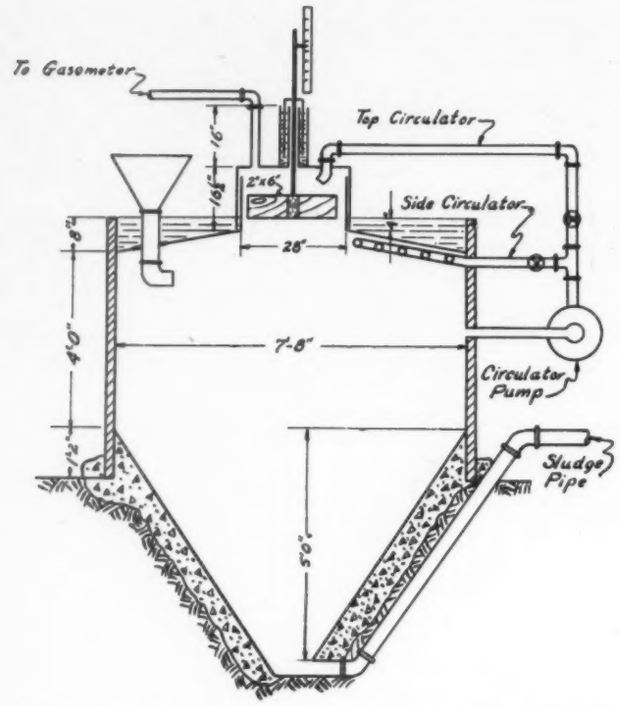
The aerobic methods of treatment, trickling filters or activated sludge, may be employed to remove dissolved organic matter but the loading limits for good results are very low.[6] Rates of 10,000 to 50,000 gallons per acre per day are required for the undiluted wastes on trickling filters and aeration periods of 24 hours or more with high air consumption are required when the activated sludge process is used. The sludge produced tends to be light and feathery and settles poorly.

One of the most embarrassing characteristics of high organic wastes is the rapidity with which they become sour. Acetic, lactic and other organic acids develop in a few hours to give acidities of several thousand parts per million. In some cases these acids develop during the normal manufacturing process and the wastes as discharged are strongly acidic. Experience has shown that sour wastes cannot be treated by aerobic methods even at the low loadings given above. Neutralization must be employed and frequently dilution is necessary, water or domestic sewage being used if available. The necessary dilution ratios run from 1 to 10 to 1 to 100. Where the industry operates only a few months a year, broad irrigation or lagooning at the rate of 10,000 gallons per acre per day may be employed.

It is apparent then that ordinary sewage treatment methods applied to industrial wastes of this character require an outlay for plant and equipment which is a heavy burden on the industry. Some manufacturing plants, to handle their wastes in this way, would have to build treatment works capable of purifying the wastes from several million people.

Since the concentrations encountered are similar to those found in the sludge from sedimentation tanks it was early suggested that these wastes might be handled as sludge is handled, namely, by anaerobic or septic digestion. Attempts to accomplish this were unsuccessful due in most cases to the extensive and rapid production of acids which arrested all further bacterial decomposition. It was noted[3] that if the wastes were diluted ten times with sewage the acidity could be controlled and complete anaerobic decomposition of the organic matter brought about. Dilution, however, has the disadvantage

*Professor of Chemistry, University of Illinois.



Digester Equipped for Scum Wetting to Equalize Alkalinity and Speed Digestion

that the total volume to be treated is increased, thereby necessitating extra tankage capacity.

In the case of wastes containing more or less fibrous material or grease, a firm scum or mat forms[5],[8] at the top of the digesting tank, frequently to considerable depths. This further hinders the process by creating an acid zone and decreasing the effective volume of the tank.

Correcting Interferences with Anaerobic Treatment

Limitations to the anaerobic method of stabilization have been under investigation in the laboratories of the Illinois State Water Survey for about ten years. The solutions proposed are as follows:

Control of Acid Production.—It has been shown by numerous investigations[2] that practically any kind of organic matter except mineral oils will decompose under the action of anaerobic bacteria to form methane and carbon dioxide. Fats, proteins, carbohydrates, alcohols, and even phenols are decomposable in this manner. The chemical reactions which take place in this decomposition occur in the main in two steps; the complex organic molecules combine with water to form the simpler organic acids (acetic, propionic, etc.) and then these acids decompose to methane and carbon dioxide. If an abundance of food material is available for the bacteria they tend to form acids more rapidly than such acids can be decomposed. It is well known that under these conditions the acid soon reaches a concentration at which all bacterial action is stopped. If on the other hand the amount of food material is properly limited the bacteria will decompose the acids as fast as they are formed, and the fermentation goes on smoothly and continuously. Fresh material may then be added regularly to the fermentation vessel in controlled amounts.

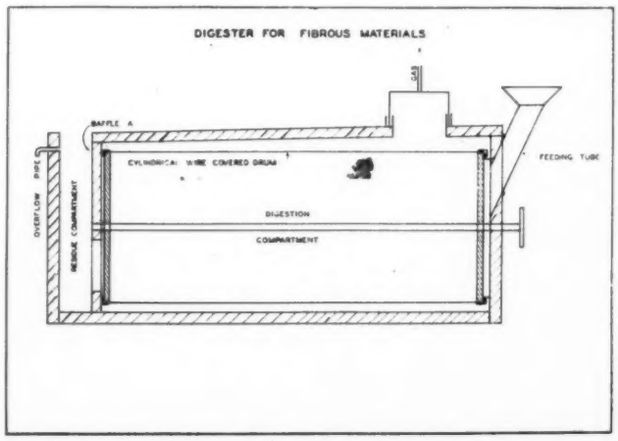
The Duclaux* method for total volatile acid is used to determine the rate of accumulation of acids during digestion. These organic acids are only slightly ionized and it is the acid radical not the hydrogen ion which must be transformed into CO_2 and CH_4. For these reasons it has not been found possible to depend on the pH determination for control of the process.

The limit of acidity for smooth continuous fermentation has been found for most materials to be about 2,000 p.p.m. calculated as acetic. When the acidity of the liquor in a fermentation tank exceeds this value it may be reduced either by decreasing the rate of feed of raw material or by dilution. Decreasing the rate of feed would involve storing or by-passing untreated waste which would be objectionable. Dilution with water may be used but we have found it advantageous to carry out the fermentation in two or more tanks operating in series and use of the spent liquor for dilution. The rate of feed is adjusted so that the acidity in the first tank is kept near the upper limit in order to obtain maximum efficiency. The secondary tanks receive the overflow liquor from the first tank at a rate to keep the acidity at a low value. To reduce the acidity the liquor from the secondary tanks may be pumped to the first tank allowing a like amount of liquor from the first tank to flow into the second tank. In other words the liquor in the two tanks is intermixed and the acidity reduced. Suppose in an installation with two tanks of equal size the acidity in the first tank has increased to 2,500 p.p.m. while that in the second is 500 p.p.m. After back circulation of liquor from the second tank for a few minutes allowing that displaced from the first tank to flow to the second the acidity will be 1,500 p.p.m. in both tanks. This is below the tolerance limit and the feed of raw material to the first tank may proceed without interruption.

Scum and Foam Control.—Wastes of a greasy or gummy character frequently produce a scum over the top of the fermentation tank. If allowed to accumulate this scum becomes sour and impairs the general operation of the tank. In our experience it can be easily controlled by pumping liquor from well above the sludge line and allowing it to flow back onto the scum. A few minutes a day of this sort of circulation is sufficient to prevent any appreciable accumulation of floating solids. Some operators have suggested circulating sludge from the bottom of the tank over the scum. This is no doubt effective but it impairs the quality of the digested sludge.

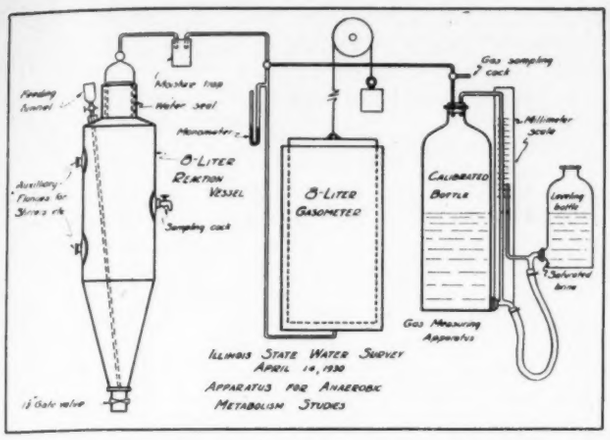
Foam may be controlled in a similar manner but in this case the discharge at the top of the tank should be at a low velocity to avoid any jetting action. A high speed jet of water frequently produces foam.

Handling Fibrous Wastes.—Packinghouse wastes[8], citrus fruit pulp, and sewage screenings[5] tend to form



The Drum-Screen Digester for Fibrous and Scum Forming Materials

*State Water Survey Bull. 30, p. 77 or standard texts on Organic Analysis.



Laboratory Equipment Used in Anaerobic Digestion and Stabilization Studies

a fibrous mat over the top of the fermentation tank which cannot be controlled by circulation as described above. A special mechanical digester[8] has been designed to solve this difficulty.

This digester consists of a perforated horizontal drum submerged in a covered tank. A feeding tube pierces the outer wall of the tank at a point within the circumference of the drum. The fibrous wastes are fed automatically or manually through the feeding tube into the perforated drum inclosed in the rectangular tank. Both ends of the drum are equipped with seal rings. These allow the drum to be turned in its bearings without the escape of fibrous material from the drum into the rest of the tank. The digester is filled with water or sewage until it runs out the overflow pipe. A gas-tight cover and water-sealed hood serve to keep out air and collect the gases formed during the digestion. Slow or intermittent revolution of the drum liberates the entrapped gas bubbles and breaks up the thick mat which collects at the top. Frequent charging of the tank with fresh waste, together with revolution or inversion of the drum causes the digested material to work itself out through the opening in the lower end of a baffle into the residue compartment. This digested material is still fermenting sufficiently to cause the entrapping of gas bubbles within its mass, which, in turn, causes it to float to the top of the residue compartment from which it can be removed periodically with forks or other suitable means.

For the treatment of beer-slop from distilleries and steep water from breweries the acid control is the most important operating factor. By taking advantage of this method of control it has been possible not only to treat these sour wastes but to handle them at loadings of 0.3 to 0.9 lbs. of organic matter per cubic foot of tank volume per day. These figures are to be compared with loadings of 0.05 to 0.08 lbs. per cubic foot for domestic sewage sludge. Table I (appended) summarizes data on a wide variety of wastes.

The gas production per unit of tank volume is of course increased proportionately by these heavy loadings. Three cubic feet of gas per cubic foot of tank volume are easily obtained and twice that rate is attainable. Since the principle cost of anaerobic fermentation is the installation charge it then decreases proportionately with increased loading rates. Gas production under these conditions is taken out of the waste disposal class and becomes a profitable manufacturing process. Calculations based on the data in Table I indicate that a gas of 540 B.T.U. can be produced for a cost as low as three cents per thousand cubic feet, although ten cents would be the cost in many cases. As the waste to be

TABLE I—FEEDING AND GAS PRODUCTION RATES OBTAINED DURING THERMOPHILIC DIGESTION OF VARIOUS INDUSTRIAL WASTES

A. Commercial Solvents' Beer-Slop (Acetonic)
   1. While fermenting rye
      3.3% Total solids, 91% volatile
      Rate of feed:
      Volume basis—½ vol./day/tank volume
      Solids basis—0.93 lbs. T.S./day/cu. ft. tank
      Gas recovery:
      Volume basis—7 vol. of gas/day/unit tank vol.
      Solids basis—7.5 cu. ft. gas/lb. T.S.*
      Rate of feed:
      Volume basis—¼ vol./day/tank volume
      Solids basis—0.62 lb. T.S./day/cu. ft. tank
      Gas recovery:
      Volume basis—4.2 vols. of gas/day/unit vol.
      Solids basis—8.6 cu. ft. gas/lb. T.S.
      Rate of feed:
      Volume basis—1/6 vol./day/tank volume
      Solids basis—0.31 lb. T.S./day/cu. ft. tank
      Gas recovery:
      Volume basis—3.0 vol. of gas/day/unit tank vol.
      Solids basis—9.7 cu. ft. gas/lb. T.S.
   2. While fermenting corn
      2.0% Total solids, 92% volatile
      Rate of feed:
      Volume basis—¼ vol./day/tank volume
      Solids basis—0.33 lb. T.S./day/cu. ft. tank
      Gas recovery:
      Volume basis—3.7 vol. of gas/day/unit tank vol.
      Solids basis—11.0 cu. ft./lb. T.S.

B. Heinz Distillery Waste
   1. 7.1 Total solids, 96% volatile pH 4.1
      Feeding rate:
      Volume basis—1/28 vol./day/unit tank vol.
      Solids basis—0.16 lb. T.S./day/cu. ft. tank
      Gas recovery:
      Volume basis—2.0 vols. of gas/day/unit tank vol.
      Solids basis—12.5 cu. ft. gas/lb. T.S.

C. Buttermilk and Whey Waste
   1. 7.0% Total solids, 91% volatile pH 5.0 High in sugars
      Feeding rate:
      Volume basis—1/29 vol./day/tank vol.
      Solids basis—0.15 lb. T.S./day/cu. ft. tank
      Gas recovery:
      Volume basis—1.6 vols. of gas/day/unit tank vol.
      Solids basis—10.7 cu. ft. gas/lb. T.S.

D. Artichoke Waste
      Rate of feed:
      0.095 lbs./cu. ft./day
      Gas recovery:
      Volume basis—0.81 vol. gas/day/unit tank vol.
      Solids basis—8.35 cu. ft. gas/lb. T.S.

E. Extracted Chicory
      Rate of feed:
      0.156 lbs./cu. ft./day
      Gas recovery:
      Volume basis—1.64 vol. gas/day/unit tank vol.
      Solids basis—10.5 cu. ft. gas/lb. T.S.

F. Sugar Beet Waste
      Rate of feed:
      0.078 lbs./cu. ft./day
      Gas recovery:
      Volume basis—0.96 vol. gas/day/unit tank vol.
      Solids basis—12.3 cu. ft. gas/lb. T.S.

G. Packinghouse Paunch Manure
      Rate of feed:
      0.37 lb./cu. ft./day
      Gas recovery:
      Volume basis—3.1 vol. gas/day/unit tank vol.
      Solids basis—8.95 cu. ft./lb. T.S.

*T.S.—Total Solids.

TABLE II—PARTIAL ANALYSIS OF CITRUS PULP

	Per cent*
Ash	0.46
Ether extract	0.38
Crude fiber	0.84
Protein	1.28
Carbohydrates	9.38
Organic nitrogen	0.197
Kjeldahl nitrogen	0.198
Total nitrogen (salicyclic)	0.208
pH	4.0
Moisture	85.5

*All of above data are on a wet basis.

TABLE III—ANAEROBIC DIGESTION OF CITRUS PULP

Bottle Number	1	2	3
Time, days	180	180	180
Weight of pulp added			
(a) Wet (gms.)	69	138	273
(b) Dry (gms.)	10	20	40
Volume of gas evolved (cc.) N.T.P.	7,045	12,955	7,105
Volatile acids as acetic at end (p.p.m.)	90	90	4,880
pH at end	6.0	6.0	5.0
Per cent digested	84.0	78.0	...

treated becomes more dilute the costs naturally increase. The character of the wastes is also a factor, the fibrous wastes decomposing more slowly than the soluble by-products.

Table III summarizes three batch experiments with citrus pulp. In our experience batch fermentation requires about ten to twenty times as long a period for a given degree of gasification as is needed when the material is fed continuously in controlled amounts. It should be possible to treat citrus pulp on a large scale at about the rate that proved satisfactory with paunch manure.

Effluent Quality

The degree of purification accomplished varies from 75 to 90 per cent. Since these raw materials frequently have B.O.D. values ranging from 15,000 to 35,000 p.p.m. the effluent B.O.D. may run from 1,000 to 3,000 p.p.m. Aerobic methods may be applied to the effluent where necessary. Naylor, more than thirty years ago, showed that even a short septic action treatment of such wastes previous to trickling filters was highly advantageous. The volume of these wastes is so small in proportion to the clean water discharge that the dilution available from this source may be sufficient in some cases. Distilleries, for example, discharge about six times as much cooling water as "beer-slop."

In some cases with which we are familiar the domestic sewage flow is ten to twenty times the volume of heavy industrial wastes. With preliminary anaerobic treatment the effluent could be discharged into the sewers without producing an abnormal industrial load.

Comparison of Costs

In so far as the anaerobic method is applicable it is decidedly the simplest and cheapest method of converting organic matter into inoffensive materials. Even in the conventional type of sewage treatment plant it is in the sludge digestion tank that 60 to 70 per cent of the organic matter is finally stabilized, the end products being insoluble combustible gas and humus.

A comparison of costs per pound of matter stabilized was worked out by the writer and Dr. C. S. Boruff for creamery wastes[6]. The figures are worthy of serious consideration.

On the basis of an average feeding of one twenty-fifth of a volume of milk waste (undiluted basis) per day per tank volume, would require 5.72 cubic feet of tank capacity for the anaerobic fermentation of one pound (dry weight) of milk waste solids. At 50 cents per cubic foot, this amounts to only $2.86 tank cost per pound of milk solids treated per day. This fermentation would remove at least 95 per cent of the pollution load. The remaining 5 per cent contained in the overflow liquor could be stabilized readily on filters. Assuming that this final treatment could be made at a cost similar to that given for filter treatment by various investigators, the total investment for complete treatment would be $8.70 per pound of solids if trickling filters were used following the anaerobic digestion, or $17.46 per pound if sand filters were used, as compared with $116.80 per pound if trickling filters were used alone, or $292 per pound if sand filters only were used. The above figures are not given to show actual costs but rather relative costs of the two processes.

Recovery of Stock Food

It is not within the scope of this paper to discuss the evaporation of wastes for stock food recovery. It is doubtful whether this can be done with profit unless the solids run higher than 7 per cent. We are certain that with 1 to 3 per cent solids the net profit is in favor of anaerobic fermentation.

As a waste disposal process evaporation is not a complete solution to the problem since the "carry-over" from the evaporators amount to 400 to 1,000 p.p.m.

The data on which this paper is based were taken from publications prepared with the writer's former collaborator, Dr. C. S. Boruff.

Acknowledgment—The above paper was presented before a joint meeting of the California Sewage Works Assn. and the Public Health Eng. Section of the American Public Health Assn. at Pasadena, Calif.

BIBLIOGRAPHY*

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2. Production of Fuel Gas by Anaerobic Fermentations. By A. M. Buswell. Ind. & Engr. Chemistry, *22*, 1168 (1930).

3. Power and Fuel Gas from Distillery Wastes. By C. S. Boruff and A. M. Buswell. Ind. & Engr. Chemistry, *24*, January, 1932.

4. The Relation Between the Chemical Composition of Organic Matter and the Quality and Quantity of Gas Produced During Sludge Digestion. By A. M. Buswell and C. S. Boruff. Sewage Works Journal, *IV*, 454, May, 1932.

5. The Anaerobic Stabilization of Sewage Screenings. By C. S. Boruff and A. M. Buswell. Sewage Works Journal, *IV*, 973, November, 1932.

6. Anaerobic Stabilization of Milk Waste. By A. M. Buswell, C. S. Boruff and C. K. Wiesman. Ind. & Engr. Chemistry, *24*, 1423, December, 1932.

7. The Anaerobic Fermentation of Extracted Jerusalem Artichoke and Sugar Beet Wastes. Thesis by Gardner B. Abbott, Dept. of Chemistry, University of Illinois, 1933.

8. Stabilization of Paunch Manures and Packinghouse Screenings. B. C. S. Boruff. Ind. & Engr. Chemistry, *25*, Page 703, June, 1933.

9. Baley J. S. C. I. *50*, 22 T.
Mills J. S. C. I. *51*, 255 T.
Mills J. S. C. I. *51*, 375 T.

*More extensive bibliographies will be found in the articles cited above.

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A Correction

Reference—"The Elimination of Check Valve Slam"—by H. K. Palmer, pages 45 and 46—February issue, WATER WORKS AND SEWERAGE.

There are three errors in the above article which have come to our attention: (1) the capital letter "A" in the formula nomenclature on page 45 should have been a small "a"; (2) on page 46 in the next to last paragraph the word "not" should appear in the following sentence: "Care must be taken to so adjust the pipe of the chamber that sufficient water is returned to close the check valve flap by the time the water comes to rest, but *not* sufficient to produce a slam"; (3) on page 45 at the bottom of the first column the word "counter-weighted" should be "weighted."

To the author and our readers we apologize for these errors. We are happy to note that all of them must be self evident to the reader and trust that they have not proved of serious consequence.

A. W. W. A. CONVENTION PROGRAM

Cincinnati, Ohio—May 6th-10th, 1935
Headquarters—Hotel Netherland Plaza.

THE program of the 55th Annual Convention of the American Water Works Association contains a variety of technical papers and topics of immediate interest and value to the water works profession.

If you have made a decision *not* to attend this centrally located convention, *don't look over this program* unless you wish to have your mind changed. The Round Table Meetings have a particularly varied list of topics for Superintendents and Managers by men who have much to offer. The Water Purification Division has a live Chairman in Sheppard Powell and a variety of material is scheduled as is also true of the Finance and Accounting Division.

Nobody will wish to miss the open committee meeting which will discuss (pro and con) the timely subject of Licensing Water Works Operators—a question of vital importance to the entire profession.

Meetings of Directors, Committees, et al.

Board of Directors—May 5 (8:00 p. m.); May 7 (5:00 p. m.); May 9 (5:00 p. m.)

Com. on Water Works Practice—May 6 (5:00 p. m.); May 8 (5:00 p. m.).

Com. on Licensing Water Works Employes—To be announced—probably May 9 (2:00 p. m.).

Editorial Committee on Std. Methods of Analysis—May 6 (5:00 p. m.).

Com. on Boiler Feed Water—May 7 (10:00 a. m.).

Com. on Cast Iron Pipe & Fittings—To be announced on Bulletin Board.

Water Works Manufacturers' Association—May 7 (10:00 a. m.).

Entertainment

May 6th—Reception and Dance.

May 7th—Ladies' Sight Seeing Trip. Annual Get Together Dinner.

May 8th—Boat Ride up the Ohio (afternoon). Smoker (Ladies invited).

May 9th—Golf Tournament, Maketewah Club. Ladies' Luncheon and Bridge. Dinner Dance (announcement of awards and prizes).

The Program

MONDAY FORENOON

(Committee Reports)

9:30 Sub-Committee 7-E, Valves, Sluice Gates and Fire Hydrants.
G. Gale Dixon (Chairman), Cons. Engr., Youngstown, O.
W. R. Conrad, Cons. Engr., Burlington, N. J.
Sub-Committee 7-T, Transite Pipe.
C. R. Knowles (Chairman), Illinois Central R. R., Chicago, Ill.
Committee on Uniform Marking of Fire Hydrants.
Stephen H. Taylor (Chairman), Supt., Water Works, New Bedford, Mass.
Committee on Licensing Water Works Employees. (Open discussion at a later meeting.)
Lewis V. Carpenter (Chairman), West Virginia University, Morgantown, W. Va.
A-21, Sectional Committee on Specifications for Cast Iron Pipe.
Thos. H. Wiggin (Chairman), Cons. Engr., New York, N. Y.
Committee on Federal Income Tax.
Committee on Code for Water Work Industry.
Wm. W. Brush (Chairman), "Water Works Engineering," New York, N. Y.
Committee on Hazards to Plant and Personnel from Use of Chlorine and Other Chemicals.
M. C. Smith (Chairman), Bureau of Water & Electricity, Richmond, Va.

11:00 Opening of Convention.
Harry E. Jordan, President.
Announcement of Officers elected for the year 1935-1936.
Reports of Secretary, Treasurer and Board of Directors.
Action on Budget.
Memorials to Deceased Members.
New Business.

MONDAY AFTERNOON

(Main Session)

Plant Management and Operation Division.
John B. Winder (Chairman), Supt., Waterworks, Dallas, Tex.

2:00 Superintendents' Round Table Discussion.
Theft of Water. Opened by C. M. McCord, Gen. Supt., Water Dept., Memphis, Tenn.
Service Connections to Water Mains. Opened by Lewis A. Quigley, Supt., Water Works, Fort Worth, Tex.
Stub Billing for Water Bills. Opened by T. G. Banks, Supt., Water Works, Oklahoma City, Okla.
Storage Yard and Material Handling. Opened by W. V. Weir, Supt., St. Louis Co. Water Co., University City, Mo.
Piece Work vs. Hourly Pay for Trenching. Opened by W. W. McClendon, City Engr., Corsicana, Tex.
Painting, Marking and Other Characteristics of Fire Hydrants. Opened by Thomas L. Amiss, Supt., Water and Sewerage, Shreveport, La.
Does It Pay to Deliver Water Bills by Hand? Opened by John Chambers, Chief Engr. and Supt., Louisville Water Co., Louisville, Ky.
[Additional Topics to Be Selected by Vote]
Service Lines—Trend in Materials and Sizes and Responsibility for Installation and Maintenance, as Between Property Owner and the Water Works.
Meter Registration and Improvements in Manufacture.
Comments on the A. W. W. A. Meter Specifications.
Customer Relations: Governing Body, Executive, Office Staff, Outside Staff.
Should Public Water Mains Be Extended into Rural Areas? How? Foreign Practice.
Use of Relief Labor and Assistance Rendered by Various State and Federal Agencies to Local Departments.
Tampering with Meters.
Private Fire Protection Systems: Size Permitted; Basis of Charge, if Any; Inspection and Control.
Use of Pipe Locators.
Should Repaired Meters Be Geared With Any But Original Factory Gears?
What Equipment Is Needed That Is Not Available?
Welding Worn or Broken Machinery.
Pipe Pushing vs. Tunneling.
Hand Trenching vs. Machine Trenching.
Assessments for Water Mains Against Frontage.
Lead vs. Compounds for Pipe Joints.
Use of Cast Iron Pipe in Lengths Longer Than Twelve Feet.
Locating Underground Structures and Leaks.
Painting and Maintenance of Elevated Tanks and Standpipes.
Making Waterworks Structures Attractive.

MONDAY AFTERNOON

(Water Purification Division)

Sheppard T. Powell (Chairman), Cons. Chem. Engr., Baltimore, Md.

2:00 Determining the Bacteriological Quality of Drinking Water.
C. T. Butterfield, U. S. P. H. S., Cincinnati, O.
J. K. Hoskins, U. S. P. H. S., Cincinnati, O.

3:00 Limiting Standards of Quality for Sources of Purified Water Supplies.
H. W. Streeter, U. S. P. H. S., Cincinnati, O.

4:00 Results of Algal Activity, Some Familiar, Others Obscure.
W. C. Purdy, U. S. P. H. S., Washington, D. C.

5:00 Committee on Water Works Practice.
Malcolm Pirnie (Chairman), Cons. Engr., New York, N. Y.

5:00 Joint Editorial Committee, Standard Methods for the Examination of Water and Sewage.
Harry E. Jordan (Chairman), Indianapolis Water Co., Indianapolis, Ind.

TUESDAY FORENOON
(Main Session)

9:30 The Drought of 1930–1934.
Discussion by:
Earnest Boyce, Chief Engr., State Board of Health, Lawrence, Kans.
H. J. Darcey, Director of San. Engineering, State Board of Health, Oklahoma City, Okla.
E. S. Tisdale, Chief Engr., State Board of Health, Charleston, W. Va.
A. H. Wieters, Director, Div. of Public Health Eng., State Dept. of Health, Des Moines, Ia.
W. H. Knox, Asst. Engr., State Dept. of Health, Columbus, O.

10:15 On Water Planning for the Nation.
Morris L. Cooke, Cons. Engr., Philadelphia, Pa., (formerly Director, Water Resources Section, National Resources Board).

10:40 Deficiencies in Present Water Resources Information.
Thorndike Saville, Prof. of San. Engineering, New York University, New York, N. Y., (formerly Executive Engr., Water Resources Section, National Resources Board).

11:00 Discussion of Preceding Papers.
F. A. Barbour, Hyd. and San. Engr., Boston, Mass. (Pres.-Elect. of the Assn.)
Abel Wolman, State Engr., P. W. A., Maryland and Delaware, Baltimore, Md.

11:30 Micro-Organisms and Water Supply of Paris, France.
John B. Hawley, Cons. Engr., Fort Worth, Tex.

TUESDAY FORENOON
(Finance and Accounting Division)
John H. Murdoch, Jr. (Chairman), Uniontown Water Co., Washington, Pa.

9:30 A Suggested Water Works Collection Procedure.
M. F. Hoffman, Commercial Supt., Dept. of Water Works, Cincinnati, O.
Discussion led by Emory C. Mathews, Asst. Treas., Board of Water Comm., Macon, Ga.

10:00 Financial History and Present Financial Policy of the Water Dept. of the City of Cincinnati, Ohio.
A. S. Hibbs, Supt., Dept. of Water Works, Cincinnati, O.
Discussion led by C. J. Aifke, Comptroller, Hackensack Water Co., Weehawken, N. J.

10:30 State Sales Taxes in Relation to Water Utilities.
Dale L. Maffitt, Gen. Mgr., Municipal Water Plant, Des Moines, Ia.
Discussion led by A. C. Kamplain, Valparaiso, Ind.

11:00 Recording Physical Property Data.
Charles Haydock, Cons. Engr., Philadelphia, Pa.
Discussion led by B. J. Lechner, Sect. & Treas., Commissioners of Water Works, Erie, Pa.

11:30 Collection of National Water Works Data.
Nathan B. Jacobs, Vice-Pres., Morris Knowles, Inc., Pittsburgh, Pa.
John W. Guilday, Morris Knowles, Inc., Pittsburgh, Pa.
Discussion led by Scotland G. Highland, Sect., Treas., & Gen. Mgr., Water Board, Clarksburg, W. Va.

10:00 Committee on Boiler Feedwater Studies.
Sheppard T. Powell (Chairman), Cons. Chem. Engr., Baltimore, Md.

TUESDAY AFTERNOON
(Main Session)

2:00 Some Engineering Problems in Connection with Raising of O'Shaughnessy Dam, San Francisco Water Supply.
Leslie W. Stocker, Civil Engr., Public Utility Commission, San Francisco, Calif.

2:30 Design and Construction of the Morris Dam, Pasadena Water Supply.
Samuel B. Morris, Chief Engr., Water Dept., Pasadena, Calif.

3:00 The Bouquet Canyon Dam and Inlet-Outlet Pipe.
W. W. Hurlbut, Water Distribution Engr., Dept. of Water & Power, Los Angeles, Calif.

3:30 Current Situation in the Public Works Program.
Malcolm Pirnie, Cons. Engr., New York, N. Y.

4:15 Sanitation Requirements for Convention Hotels.
F. H. Waring, Chief Engr., State Board of Health, Columbus, O.
Joel I. Connolly, Chief, Bureau of Public Health Engineering, Chicago, Ill.

TUESDAY AFTERNOON (Continued)
(Water Purification Division)

2:00 Report on a Study of Various Selective Media for Coli-Aerogenes Isolation.
John R. Norton, The Upjohn Co., Kalamazoo, Mich.
C. C. Ruchhoft, San. District of Chicago, Chicago, Ill.

3:00 The Relative Growth of Recently Isolated and Stock Strains of Bact. Coli and Bact. Aerogenes in Various Culture Media, as Measured by the Butterfield-Hoskins Method.
R. E. Noble, Board of Health, Chicago, Ill.

4:00 Report of the Committee on Tests and Specifications of Chemicals Used in Water Purification.
Mathew M. Braidech (Chairman), Senior Chemist, Baldwin Filtration Plant, Cleveland, O.

WEDNESDAY FORENOON
(Main Session)

9:30 Future Growth of American Cities.
C. A. Dykstra, City Mgr., Cincinnati, O.

10:00 Economic Security.
Henry M. Waite, Director, Dept. of Economic Security, Cincinnati, O.

10:15 Reconditioning Water Supply Mains with Bituminous Enamel.
Linden Stuart, Pres., Wailes Dove-Hermiston Corp., New York, N. Y.
Discussion led by Andrew B. Mauzy, Chief Engr., Bureau of Water, Jersey City, N. J.

11:00 Cement Lining of Large Diameter Mains in Place by Centrifugal Machine.
Elson T. Killam, Cons. Engr., New York, N. Y.

11:45 Applying Cement Mortar Lining to Existing Mains in England.
Thos. H. Wiggin, Cons. Engr., New York, N. Y.
Discussion by F. N. Speller, Director of Research, National Tube Co., Pittsburgh, Pa.

WEDNESDAY FORENOON
(Water Purification Division)

9:30 The Preparation of Fine Anthracite for Use in Filter Plants.
E. L. Buller, Research Engr., Hudson Coal Co., Scranton, Pa.

10:15 The Determination of Dissolved Oxygen.
C. H. Fellows, Research Dept., Detroit Edison Co., Detroit, Mich.

11:00 Colorimetric Dissolved Oxygen Method.
F. W. Gilcreas, Div. of Laboratories and Research, State Dept. of Health, Albany, N. Y.

11:45 Report of the Committee on Testing Zeolites.
Charles P. Hoover, Cons. Chemical Engr., Columbus, O.

THURSDAY FORENOON
(General Membership and Water Purification Division)

9:30 Progress in Abating Pollution of Water Supplies by Mine Wastes.
H. R. Crohurst, San. Engr., U. S. P. H. S., Cincinnati, O.
Chester F. Drake, Div. Supt., Pittsburgh Filtration Plant, Aspinwall, Pa.
R. E. Tarbett, San. Engr., U. S. P. H. S., Cincinnati, O.
E. S. Tisdale, Chief Engr., State Board of Health, Charleston, W. Va.

10:15 Observations on Corrosion of Wrought Iron and Steel Pipe in Buildings.
Wm. W. Brush, Editor, "Water Works Engineering," New York, N. Y.

11:00 Effect of Excess Lime Hydrate Upon the Corrosive Properties of the Soft Catskill Water.
F. E. Hale, Director of Labs., Dept. of Water Supply, Gas and Electricity, New York City.

11:45 Discussion of Two Preceding Papers.
F. N. Speller, Director of Research, National Tube Co., Pittsburgh, Pa.
Fletcher Collins, Sect., Wrought Iron Pipe Assn., New York, N. Y.

THURSDAY FORENOON
(Finance and Accounting Division)

9:30 The Relation of Engineering and Accounting to Depreciation for Rates and Taxes.
E. E. Bankson, Cons. Engr., Pittsburgh, Pa.
Discussion led by Louis D. Blum, Cert. Pub. Acct., New York, N. Y.

10:00 Should Municipal Plants Be Regulated by State Utility Commissions and Be Subject to Local, County, State and Federal Taxation?
Joseph A. Beck, Attorney at Law, Pittsburgh, Pa.

10:40 A Uniform Classification of Accounts Suitable for Publicly and Privately Owned Utilities.
Harry Boggs, Cert. Pub. Acct., Indianapolis, Ind.

Discussion led by W. S. Patton, Mgr., Water Works, Ashland, Ky.

11:30 A Review of the Special Lien Bond Situation.
Robert A. Taft, Attorney at Law, Cincinnati, O.
Discussion led by Stewart A. Hoover, Attorney at Law, Columbus, O.

12:30 Luncheon. Meeting.
Round Table Discussion on "A Uniform Classification of Accounts Suitable for Publicly and Privately Owned Utilities," led by Messrs. Boggs, Patton and Blum.

THURSDAY AFTERNOON

(Plant Management and Operation Division)

2:00 Is a Record System of Underground Water Mains Justifiable?
E. A. Munyan, Mgr., Gas & Water Depts., Union Gas & Electric Co., Cincinnati, O.

2:45 Developments in Water Works Practice During the Year.
Dams and Pipe Lines, Thos. H. Wiggin, Cons. Engr., New York, N. Y.
Purification and Treatment, Linn H. Enslow, Editor, "Water Works and Sewerage," New York, N. Y.
Distribution and Service, Wm. W. Brush, Editor "Water Works Engineering," New York, N. Y.

3:30 Superintendents' Round Table Discussion.
Public Relations in the Water Department. Discussion led by W. H. Vaughn, Water Superintendent, Fort Smith, Ark.
The Superintendent's Position Relative to the Public and the Governing Body. Discussion led by R. B. Simms, Supt., Water Works & Sewerage, Spartanburg, S. C.
Waco and Its Experiences with the Commission Management of Its Water Works. Discussion led by Geo. J. Rohan, Supt. of Water Works, Waco, Tex.
[Additional Topics to Be Selected by Vote]
Inspection of Fire Hydrants and Division of Responsibility Between Fire and Water Departments.
Control of Sizes of Customers' Services.
Several Small Meters vs. One Large Meter for Large Services.
Organization of Water Departments for Emergencies.
Consumers' Complaints and How to Meet Them.
Special Water Rates for Sprinkling.
How Often Should Water Meters Be Tested?
Patents, as They Affect Water Departments.
Collection of Delinquent Water Bills; Adjustments in Water Bills.

THURSDAY EVENING

7:30 Dinner Dance. (Informal.)
Address by Hon. Russell Wilson, Mayor of Cincinnati, President Harry E. Jordan and President-Elect Frank A. Barbour.
Presentation of John M. Diven Memorial Medal to Linn H. Enslow.
Presentation of John M. Goodell Prize to F. E. Hale.
Introduction of Newly Elected Honorary Members—Wm. Molis and Denis O'Brien.

Exhibitors

The following firms will exhibit at the Cincinnati Convention, Hotel Netherland Plaza, May 6th-10th:

Addressograph-Multigraph Co., Cleeland, O.
American Brass Co., Waterbury, Conn.
American Cast Iron Pipe Co., Birmingham, Ala.
The American City Magazine, New York City.
The American Rolling Mill Co., Middletown, O.
Atlas Mineral Products Co., Mertztown, Pa.
Badger Meter Mfg. Co., Milwaukee, Wis.
Bingham & Taylor Corp., Buffalo, N. Y.
Birch Manufacturing Co., Chicago, Ill.
W. A. Briggs Bitumen Co., Philadelphia, Pa.
Buffalo Meter Co., Buffalo, N. Y.
Builders Iron Foundry, Providence, R. I.
The Central Foundry Co., New York City.
Chapman Valve Mfg. Co., Indian Orchard, Mass.
Chicago Bridge & Iron Co., Chicago, Ill.
H. W. Clark Co., Mattoon, Ill.
Darling Valve & Mfg. Co., Williamsport, Pa.
DeLaval Steam Turbine Co., Trenton, N. J.
Dorr Co., New York City.
S. R. Dresser Mfg. Co., Bradford, Pa.
Eddy Valve Co., Waterford, N. Y.
Engineering News-Record, New York City.
Ford Meter Box Co., Wabash, Ind.
W. & L. E. Gurley, Troy, N. Y.
Fred W. Hanks Co., Cleveland, O.
Hays Mfg. Co., Erie, Pa.
Hersey Mfg. Co., South Boston, Mass.
Hydraulic Development Co., New York City.
Industrial Chemical Sales Co., New York City.
International Filter Co., Chicago, Ill.
Jenkins Bros., Bridgeport, Conn.
Johns-Manville Corp., New York City.
Kennedy Valve Co., Elmira, N. Y.
The Leadite Co., Philadelphia, Pa.
Lead Lined Iron Pipe Co., Wakefield, Mass.
Lock Joint Pipe Co., Ampere, N. J.
Ludlow Valve Mfg. Co., Troy, N. Y.
McWane Cast Iron Pipe Company, Birmingham, Ala.
M. & H. Valve & Fittings Co., Anniston, Ala.
Mueller Company, Decatur, Ill.
National Meter Co., Brooklyn, N. Y.
National Tube Co., Pittsburgh, Pa.
National Water Main Cleaning Co., New York City.
Neptune Meter Co., Long Island City, N. Y.
The Pardee Engineering Co., Long Island City, N. Y.
The Permutit Co., New York City.
Phoenix Meter Co., Prince Bay (S. I.), N. Y.
The Pitometer Co., New York City.
Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa.
Public Works, New York City.
Rensselaer Valve Company, Troy, N. Y.
Ross Valve Mfg. Co., Inc., Troy, N. Y.
Simplex Valve & Meter Co., Philadelphia, Pa.
The A. P. Smith Mfg. Co., East Orange, N. J.
S. Morgan Smith Co., York, Pa.
R. W. Sparling, Los Angeles, Cal.
The Syntron Co., Pittsburgh, Pa.
Thomson Meter Corp., Long Island City, N. Y.
Union Water Meter Co., Worcester, Mass.
U. S. Pipe & Foundry Co., Burlington, N. J.
The Vellumoid Co., Worcester, Mass.
Vogt Bros. Mfg. Co., Louisville, Ky.
Revere Brass & Copper Incorporated, New York City.
Wailes Dove-Hermiston Corp., New York City.
Wallace & Tiernan Co., Inc., Newark, N. J.
Water Works Engineering, New York City.
WATER WORKS & SEWERAGE, Chicago and New York.
Western Gas Construction Co., Fort Wayne, Ind.
R. D. Wood & Co., Philadelphia, Pa.
Worthington-Gamon Meter Co., Harrison, N. J.

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A. W. W. A. "Bargain" Membership Proves Highly Popular

In connection with the coming A. W. W. A. Convention, to be held at Cincinnati, May 6th-10th, the American Water Works Association is offering a special "bargain rate" membership.

For a total of $5.00—as against the regular $5.00 initiation fee and $10.00 annual dues—non-members may join the Association for the eight months' period, May 1st to December 31, 1935.

This makes it possible to secure advantage of the reduced railroad rate for the Cincinnati Convention and also to receive copies of the A. W. W. A. Journal (annual subscription to non-members, $7.00) as well as to participate in all Association affairs for the balance of the year.

First announced at the Florida Section meeting March 27th, this bargain rate resulted in a rush of applications, increasing the sectional membership by more than fifty per cent. Later at the Southeastern Section meeting in Birmingham, Ala., 25 new members availed themselves of the opportunity.

Open until May 1st, this special offer is too big a bargain to be overlooked. Merely address A. W. W. A. Headquarters, 29 W. 39th St., stating that membership is desired and attach the fee of $5.00. A convention trip reduced fare certificate should also be requested with your application.

EDITORIAL

Another "Forgotten Man"

OLD age security and unemployment insurance, the immediate focal points of attention in Washington, are matters of intense interest and prime importance to the nation at large. The so-called Wagner bill now in the process of formulation, if not already presented to Congress by the time this is read, covers the matter of pensioning of individuals who have become obsolete, so to speak, or who have reached an age to warrant retirement from active duty. It is extremely regrettable that benefits from this important social planning are denied federal, state and municipal employes, in the proposed legislation. To these servants of the public (government) the term "Old Age Security," as it is applied in the Wagner bill, will have a hollow sound.

Water works employes will find it difficult to understand the justice of the Federal Government's classification of municipal water works employes as utility employes when it comes to demanding from them income taxes, whereas, they become disbarred along with all other municipal employes (including "job holders") when it comes to possible participation in the benefits of an old age pension and unemployment insurance under the Old Age Security Act now in the making.

There has been much talk during recent times about this and that "forgotten man." An article elsewhere in this issue by Harry E. Jordan, President of the American Water Works Association, is a timely one for he discusses the very unsatisfactory, many times ill fated, position of worthy and capable executives and technically trained personnel who serve municipalities. He points to the fact that in the "new deal" water works employes are certainly amongst the "forgotten men." He discusses the fruitlessness of raising the standards and qualifications and the hopelessness of insuring security of positions of municipal water works personnel so long as there is political control or domination of the city water department. A plea is made, that something be done in a concerted manner to preclude the possibility of displacement of competent and faithful water works or sewerage employes as the result of a change of the political complexion of City Hall. Mr. Jordan sees a way out of this situation through the adoption of state licensing acts, which will require the filling of positions of responsibility, and those requiring specialized knowledge in water works or sewerage system operation, only by individuals who have qualified under the law as a "Licensed Operator," "Licensed Engineer," etc.

Such a method of insurance against appointments of incompetent or unqualified personnel will add greatly to security of position of water works and sewerage employes—especially General Superintendents, Managers, Engineers in Charge, Superintendents of Purification Plants or Treatment Works and Chief Operators—many of whom give the better part of their lives to public service only to find that there is no way of beating a game when fair dice are switched for loaded ones. The other strong feature of licensing acts is that they have the value of insuring protection to a citizenry that every day places its safety and health in the hands of its water department personnel.

Water works and sewerage executives and other employes in responsible position are already coming to appreciate that an effectively drawn and forcefully administered Operator Licensing Act can mean much to themselves and the profession at large. They will find their positions made secure and responsibility less hazardously delegated if they will work for the passage of such laws. They would do well to encourage action toward securing a licensing act by getting established a Committee on Licensing, consisting of active operating men, in their Section of the American Water Works Association, or other sectional water works or sewerage group with which they are identified. They should also petition their State Department of Health to assist in this move. It should be the duty of such Committees on Licensing to study existing licensing acts (already in at least 6 states) from the operators' point of view. And therefrom, and in cooperation with the State Department of Health, pattern an act which will prove workable in the particular state. Acting thus, will give the operator a voice in the framing of the act and the Department of Health the needed support and assistance in getting the act through the legislature in a form satisfactory to all concerned—except, possibly, the political machine in City Hall.

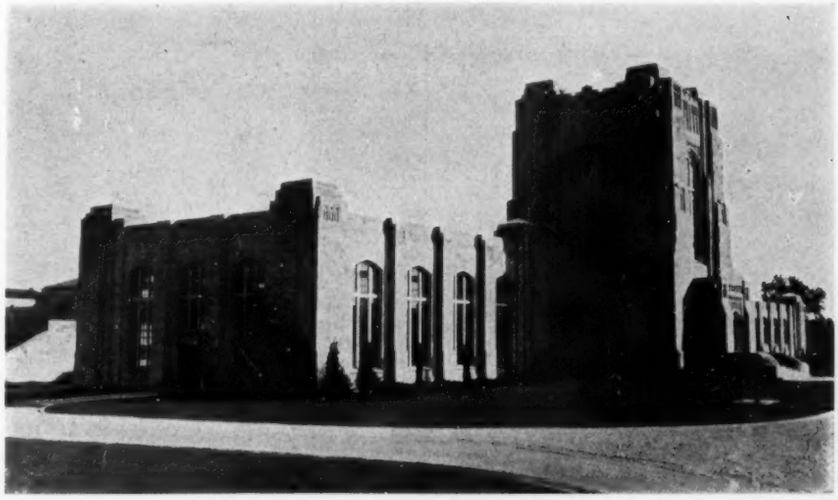
In this direction the Southeastern Section of the A. W. W. A. took forward looking action, at its recent meeting at Birmingham, Ala., when a resolution was passed and a Committee on Licensing named to look into the workability and results from existing operator licensing acts. The resolution stated, in effect, that if such an act seemed desirable in the states represented (S. C., Ga., Ala., and Miss.) that a model act be drawn for consideration by the Southeastern Section with the intent to recommend its passage by the legislatures of each of the four states represented. The American Water Works Association taking cognizance of the value of operator licensing will hold a special open committee meeting, during the Cincinnati Convention, for the purpose of a discussion of this subject with the thought of drafting a model act to serve as a basic pattern to all states considering passage of licensing acts. Certainly the idea of a uniform act is a laudable one, making for simplification in the matter of a licensed operator transferring from one state to another.

So much for the value to active operators of licensing acts for increasing recognition of merit and security of position. But, there is need for additional consideration of the "forgotten man"—the faithful but worn-out water works employe. In some of the larger cities a retirement pension system for municipal employes is in force, but not so for the great majority of water works and sewerage men. While Congress is arranging to take care of the butcher, baker and candlestick maker, the municipal water works manager reaching retirement age must depend upon fate. What can be done to at least put a water works superintendent, suffering obsolescence, on an equal footing with the "retired" fire department horses of a few years ago? Is this not a proper matter to be placed before a special committee within the A. W. W. A.? Is it not a worthy project for this committee to investigate the possibilities of securing old age retirement insurance at a group plan rate—even though it requires an additional paid association personnel to administer the plan? Ability to purchase such insurance through the Association might be made contingent on membership therein. Such a scheme, if found practicable would serve a dual function—that of strengthening the Association by numbers, and that of offering a very real and appreciated personal service to its members. If there be another organization better fitted to undertake this duty then this suggestion is out of order—but, where is it?

A PRESENTATION OF REPRESENTATIVE AMERICAN WATERWORKS PLANTS

Sacramento, Calif.

Filtration Plant, Water Tank, Laboratory and Offices



Fort Wayne, Ind.

High Service Pumping Station

From the groupings of pictures a committee of architects will be asked to select the three most attractive or unusual plants. Our readers are also invited to name their 1st, 2nd and 3rd selections. Prize awards are to be made.

COAST TO COAST!

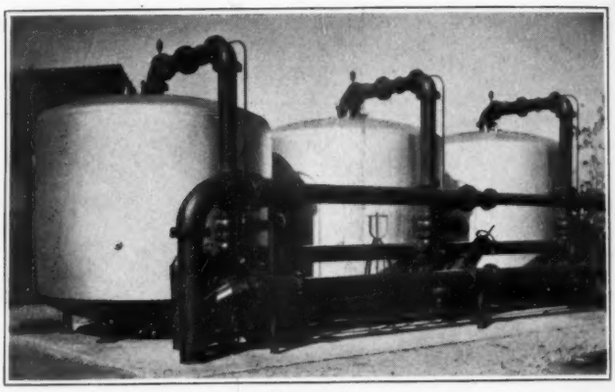
Sebago Lake to Salton Sea

Portland, Me. (Portland Water Dstrict), Shops and Garages

Portland, Me.

One of the High Pressure Emergency Pumping Stations

Culver City, Calif.

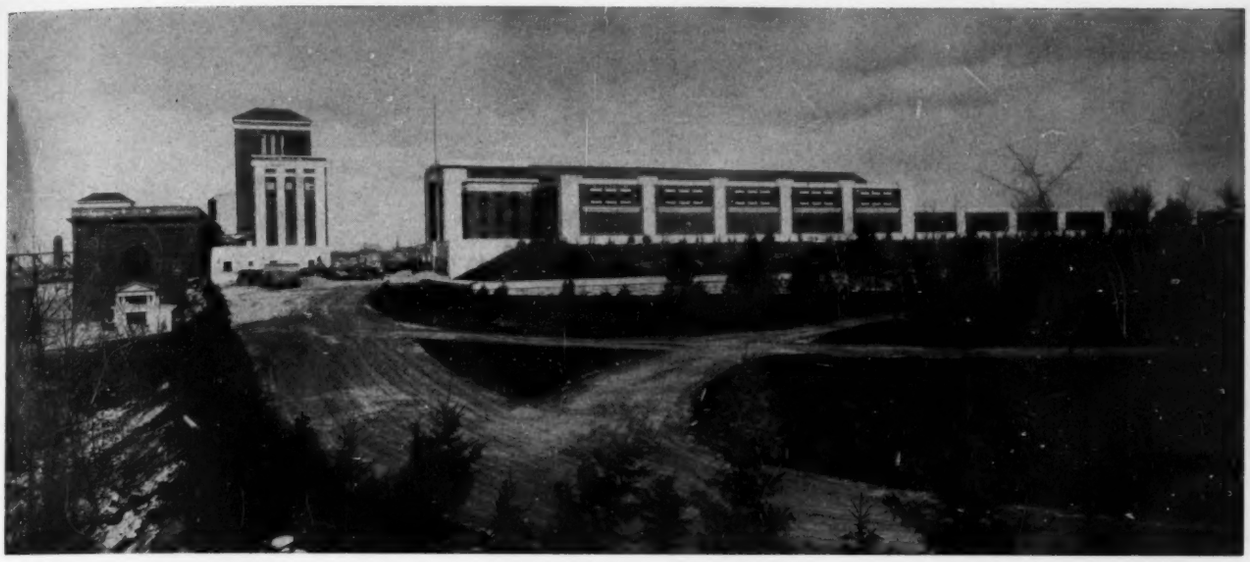


Super-Chlorination and "Hydradarco" Activated Carbon Filter (American States Water Co.) Makes the Water Brilliant and Movie Stars More Brilliant

Claremont, Calif. (American States Water Co., C. P. Harnish, Genl. Mgr.), Deep Well Pumping Station and Aerators

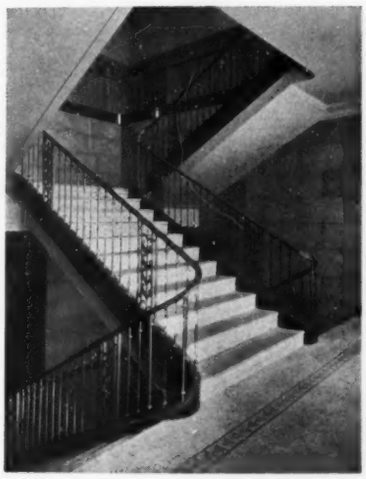
Ottawa

The Capital of the Canadian Dominion Takes a Rightful Pride in Its Filtration Plant.



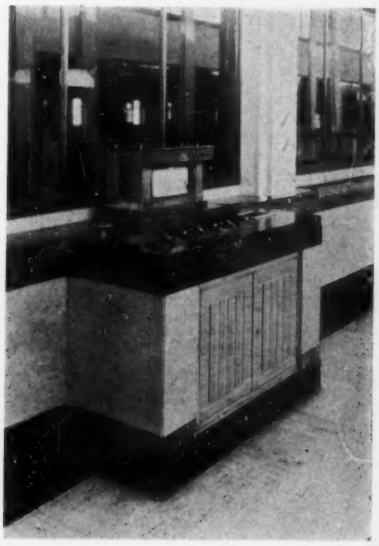
35 M.G.D. Filtration Plant and Pumping Station. (Gore, Nasmith and Storrie, Engs., W. E. MacDonald, Water Engr.)

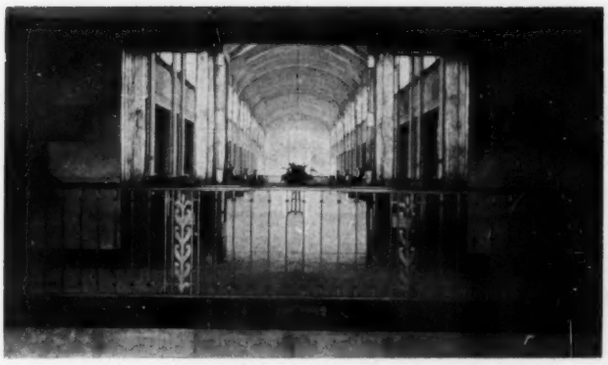
Central Staircase



Main Entrance to Plant

Filter Table.





Main Operating Gallery

Ottawa, Canada

35 *M.G.D. Filter Plant. A Near View of Operating Floor*

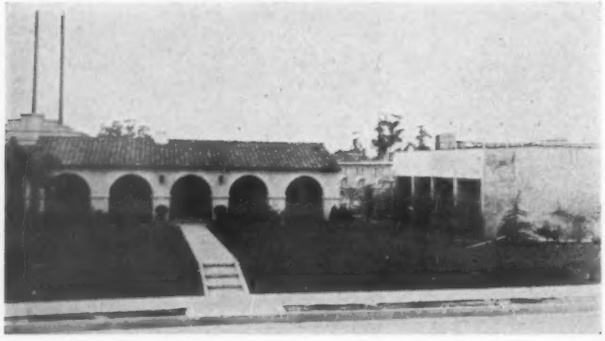
Los Angeles, Calif.

A. Chlorination Station—Typical of All Recent Installations—This One in Griffin Park, Los Angeles

Sacramento, Calif.

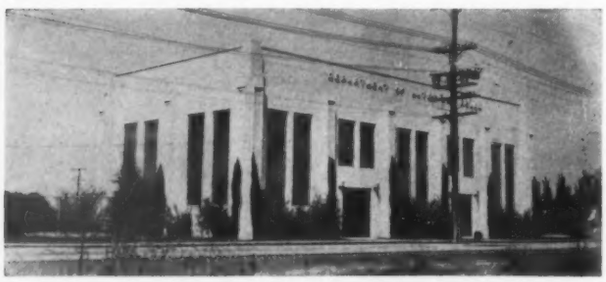
Electric Fountain and Fish Pool

Los Angeles, Calif.



Wilmington Filtration Plant (6 M.G.D.). An Unusual Design with Filters Outside and Uncovered Operating Gallery—Coagulant Used Is Ferric Chloride

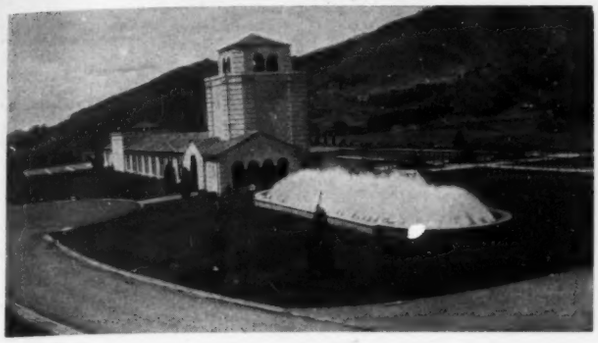
Operating Gallery
(Chas. Gilman Hyde, Engr.)



Van Owen Pumping Station (65 M.G.D.). Delivers Water from Well Field in San Fernando Valley Only When Gravity Supply Is Depleted or in Emergencies

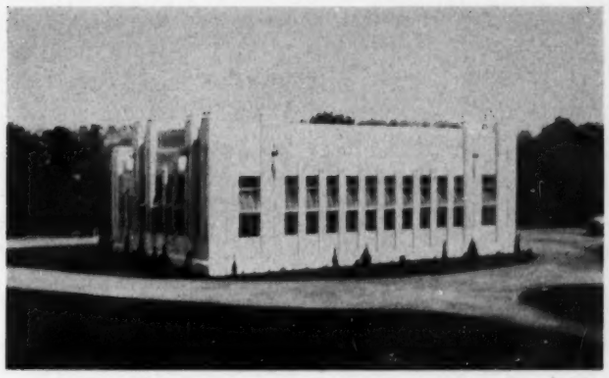
Pumping Station at Filtration Plant

Oakland — Berkley, Calif.



Upper San Leandro Filtration Plant (18 *M.G.D.*) *East Bay Utilities Commission, J. S. Longwell, General Manager*

Tacoma, Wash.

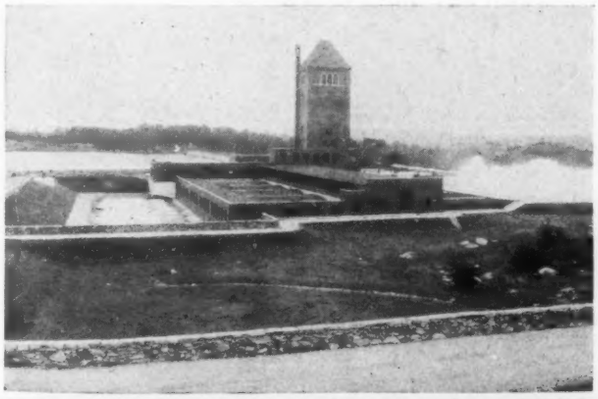


Hood St. Pumping Station. (W. A. Kunigk, Supt. Water)

Elizabeth City, N. C.

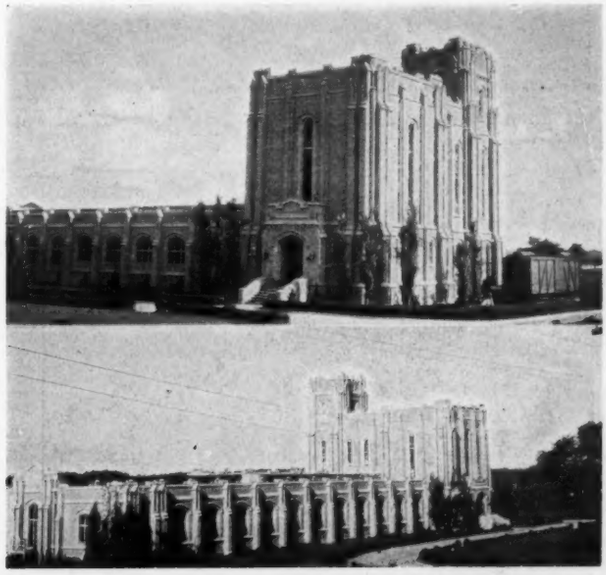
A. M. G. Filtration Plant and Pumping Station. Here Chlorinated-Copperas Was First Employed in Water Coagulation. (Wm. C. Olsen, Engr.)

Providence, R. I.



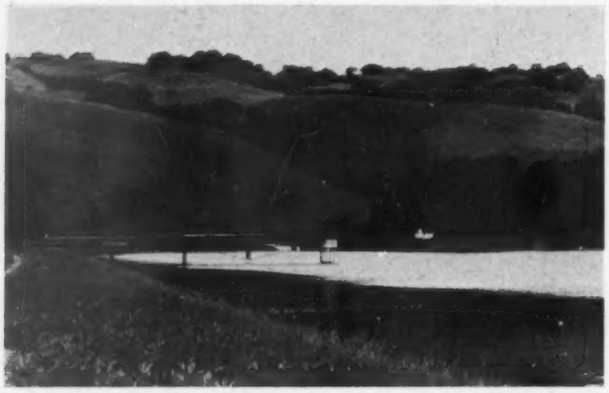
Filtration Plant and Aerator. The First Large Plant to Use Chlorinated-Copperas in Coagulation. (Malcolm Pirnie, Engr.)

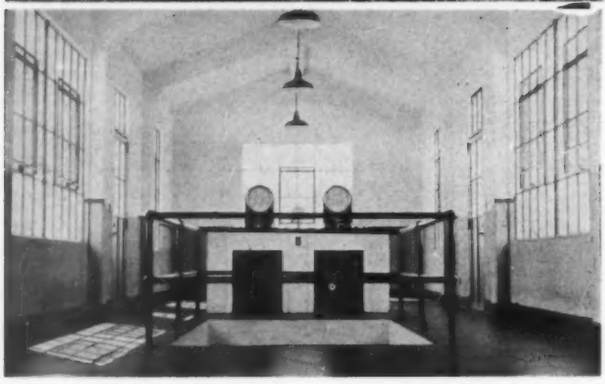
Cedar Rapids, Ia.



Softening-Filtration Plant and Pumping Station. (H. F. Bloomquist, Supt. W. W.) (Alvord Burdick & Howson, Engrs.)

Contra Costa, Calif.





(California Water Service Co., a Unit of Federal Water Service Co.) Above—Reservoir. Center—Chenery Filter Plant (4 M.G.D.) Bottom—Operating Gallery (Chenery).

Grants Pass, Oregon

Filtration Plant (Before Landscaping). (Barr and Cunningham, Engrs.)

Grays Harbor, Wash.

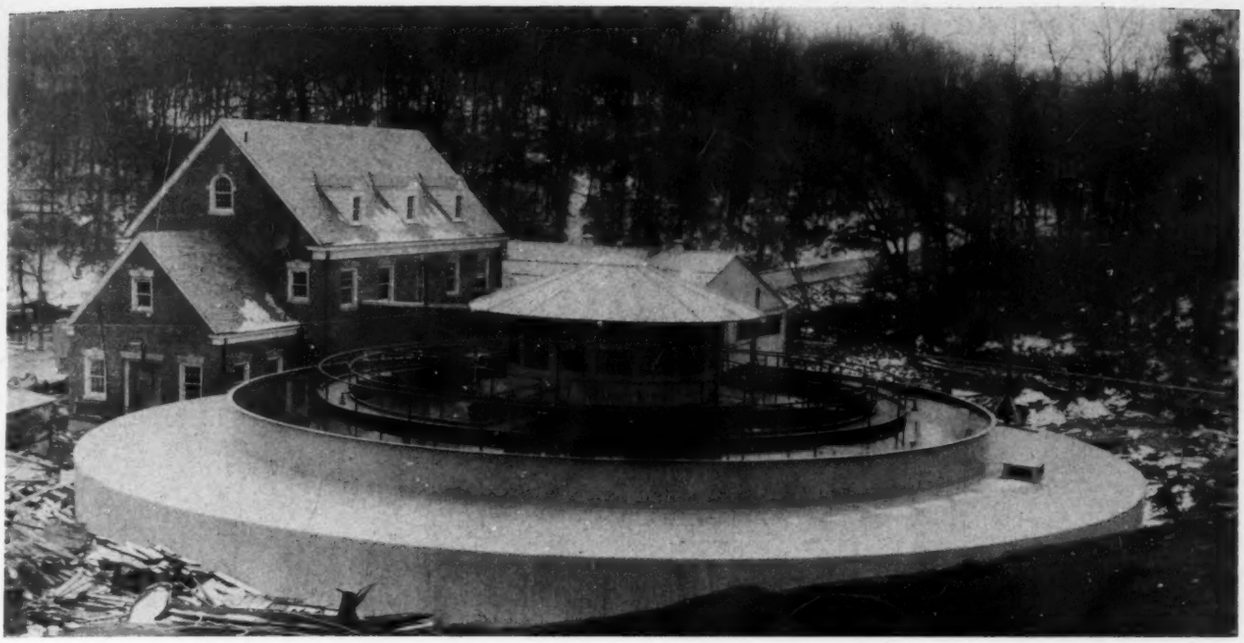
Pumping Station on Wishkah River. Filter Plant Not Visible. (Barr and Cunningham, Engrs.)

Youngstown, Ohio

(Mahoning Valley Sanitary District)
Above—Meander Creek Dam. Below—Softening-Filtration Plant (Right). Pumping Station (Left). (G. Gale Dixon, Engr.)

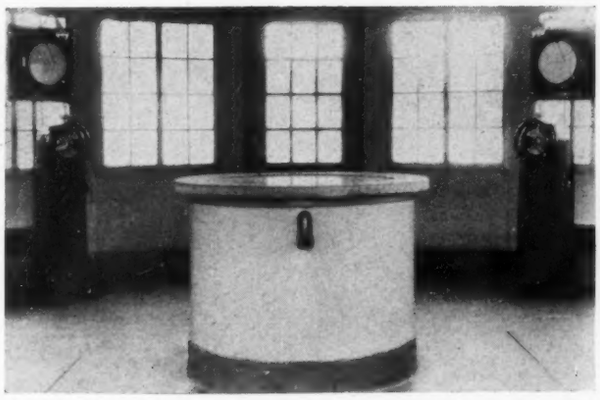
AT BURNT MILLS, MD.

America's Most Unique Filtration Plant

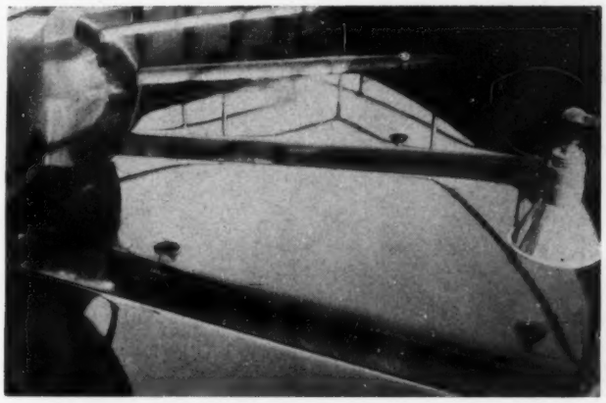


Conceived and Designed by Robert B. Morse, Chief Engr. Washington Suburban Sanitary District.

The Newest Thing in Filter Plants—The First 5 M.G.D. Unit of "Tanks within Tanks," Based upon Its Success, Is to Have a "Twin," Now in the Making. The Outside Covered Circumferential Tank Is Clear Water Storage; Then Comes the Coagulation Tank; Then the Pie-Shaped Filters (in the Open) Which Surround the Pipe Well (gallery) at Center Surmounted by the Operating "Pilot House."



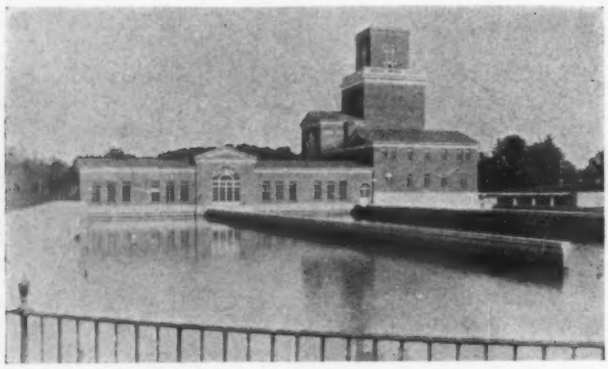
The "Pilot House," Showing Operating Control Stands, Gages and Control Sight Well. In This "Pilot House" It Is Always "Full Speed Ahead."

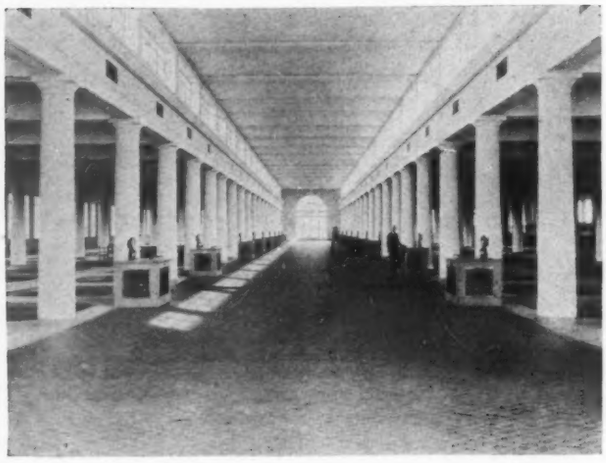


One of the Four Fan-Shape False Bottom Filter Units During Washing.

Corner of Pump House

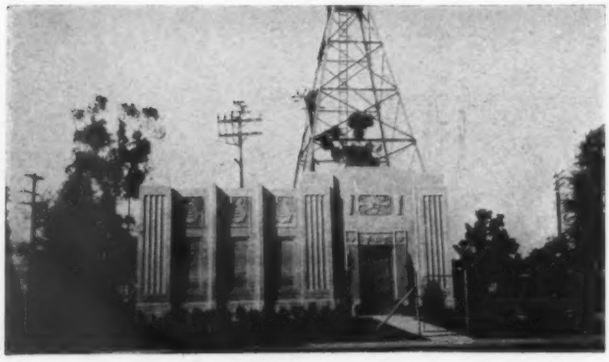
Washington, D. C.

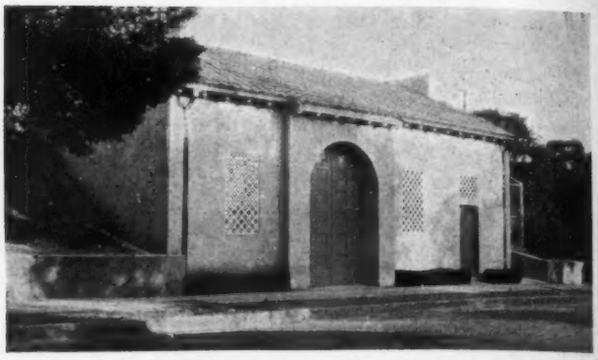


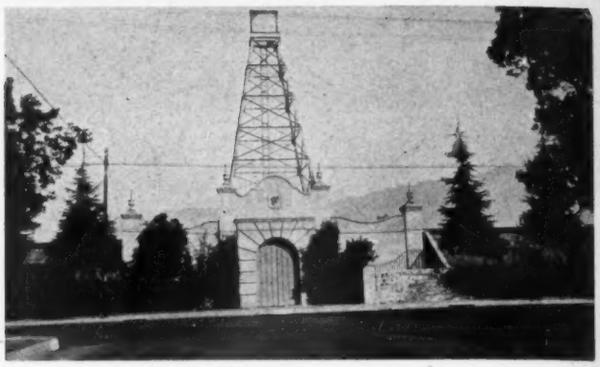


(Dignified Dalecarlia Filters) The Plant. 80 MGD. Cap. Entrance Lobby and Fish Pool. Operating Floor—(20 Units)

Pasadena, Calif.

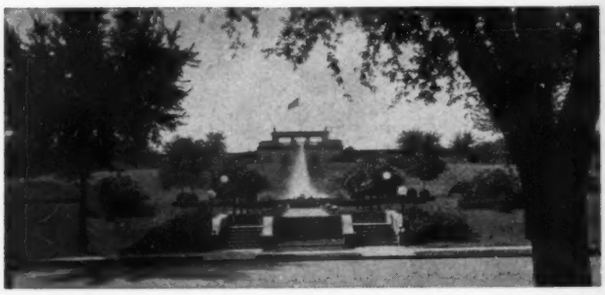


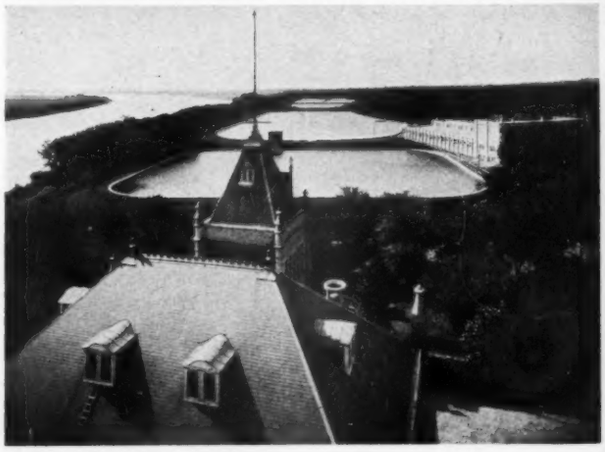




Two Deep Well Stations and a Typical Booster Pumping Station (upper) in Residential Areas. One Well (Woodbury) (1220 ft. Deep and 26 in. Diam.) Is Thought to Be the Deepest Well of Such Diameter in This Country. (S. B. Morris, Ch. Engr. & Gen. Mgr. Water Dept., Pasadena, Calif.)

Omaha, Nebr.





Above—Walnut Hill Reservoir and Pumping Station. Below—Florence Reservoirs, Filtration Plant (right) and Pumping Station in Foreground. (T. A. Leisen, Genl. Mgr. Utilities)

Tampa, Fla.

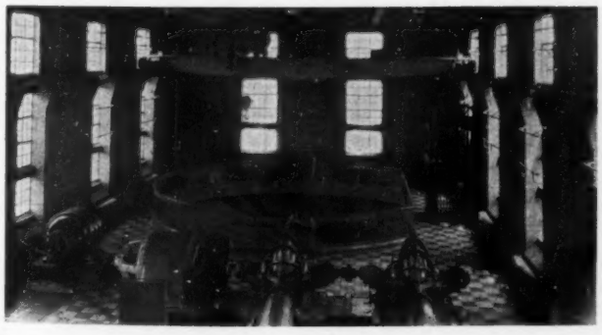
Hillsborough Filters

Entrance to Filter House

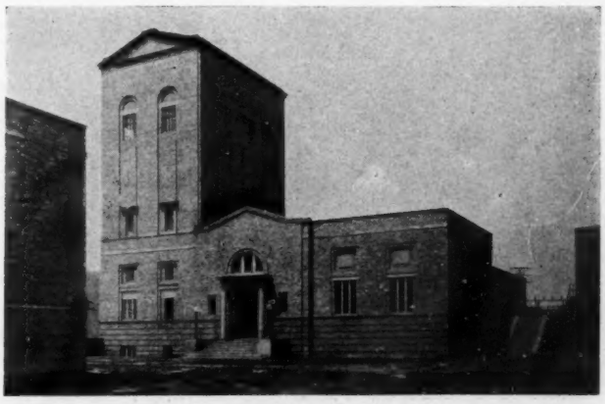
Operating Floor

Hillsborough Filtration Plant and Pumping Station, Tampa, Fla. (Nicholas S. Hill, Jr., Engr.)

Wheeling, W. Va.

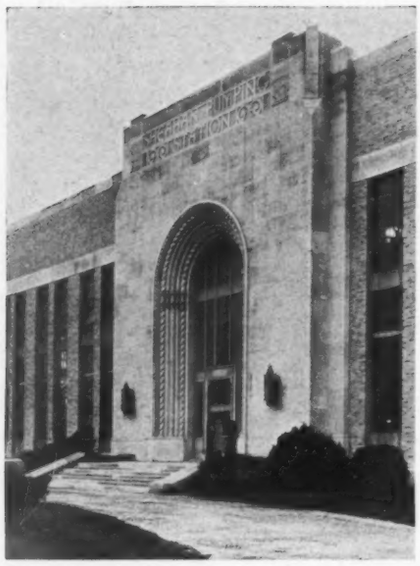


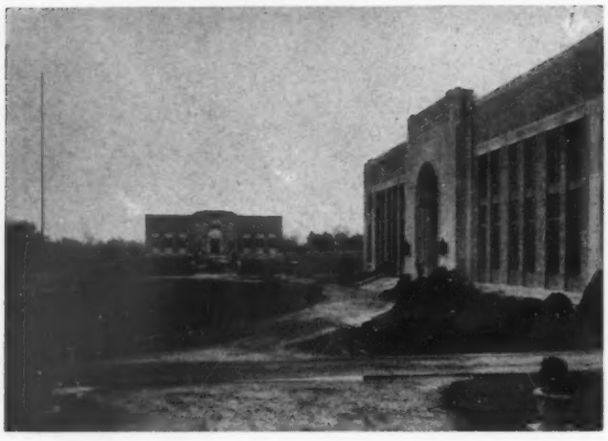
High and Low Service Pumping Station



Filtration Plant Adjoining. (J. N. Chester, Engr.)

Memphis, Tenn.





The Newer of Two Iron Removal-Filtration Plants. Above—Sheehan Pumping Station. Below—Aeration-Filtration-Iron Removal Plant (Left Rear) and Pumping Station (Right). (Fuller and McClintock, Engrs.) Note—Memphis Now Probably Has by All Standards the Nearest to a Perfect Quality of Water of any American City—Editor.

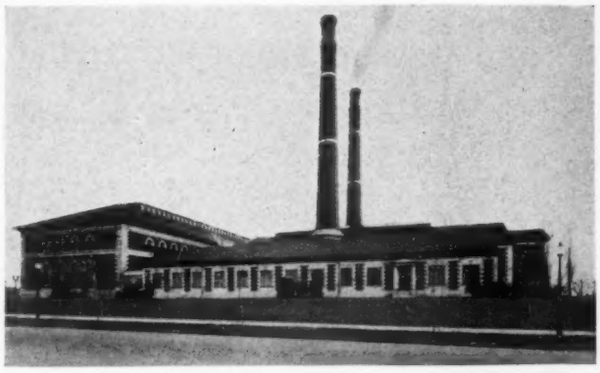
Bridgeport, Conn.

One of the Chlorinating Stations of the Bridgeport Hydraulic Co.—Nestled below the Dam. Note Landscaping.

Salem, Va.

An Attractive Well Operated Small Town Filtration Plant on the Lee Highway

Buffalo, N. Y.

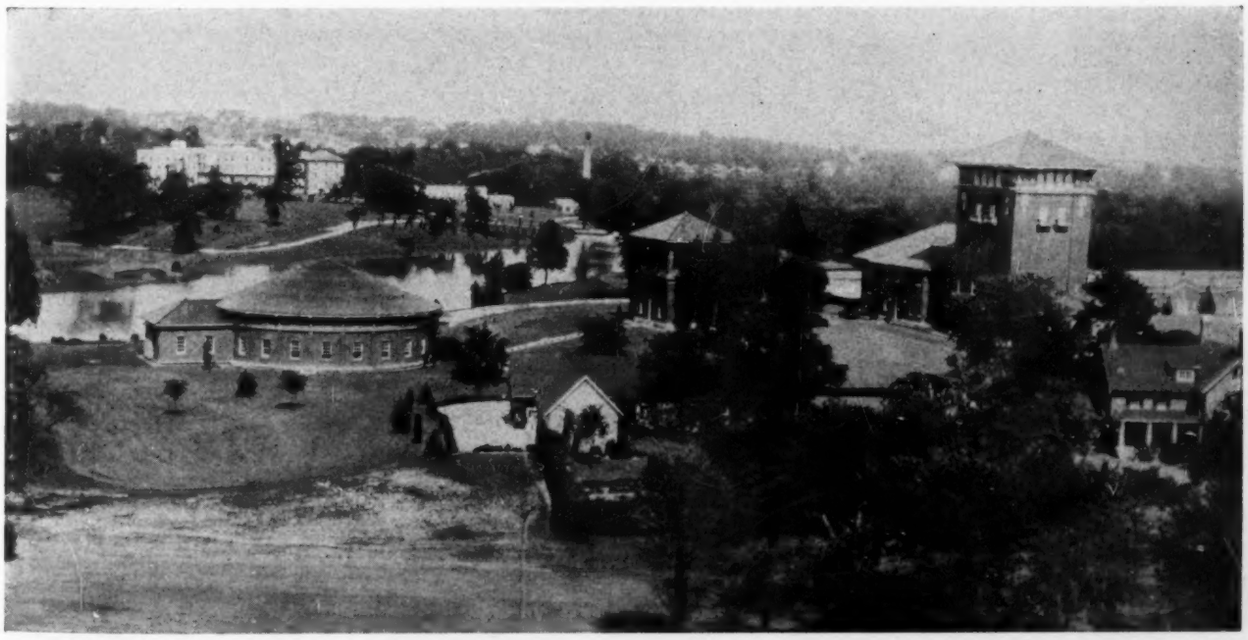


(Alan D. Drake, Director of Water)
Top—Col. Ward Pumping Station. Center—160 M.G.D. Filtration Plant and Pumping Station. Bottom—Operating Floor of Plant. (Fuller and McClintock, Engrs.)

West Palm Beach, Fla.

Filtration Plant and Pumping Station of West Palm Beach Water Co. (Designed by Malcolm Pirnie, Cons. Engr., Operated by Ralph W. Reynolds, Mgr.) To Adjust pH for Coagulation Deep Well Water of High pH Value is Mixed with Low pH Surface Supply

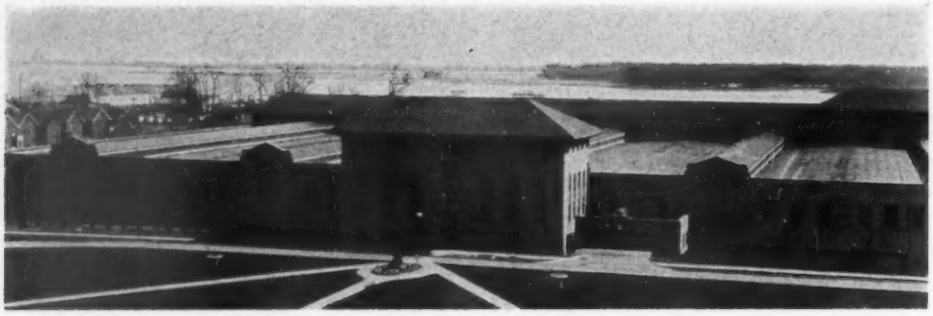
Baltimore, Md.



Montebello Filters—Aluminum Sulphate Is Produced by the Hoover Process. (Jas. W. Armstrong, Engr.)

The World's Largest Filter Plant

Detroit, Mich.

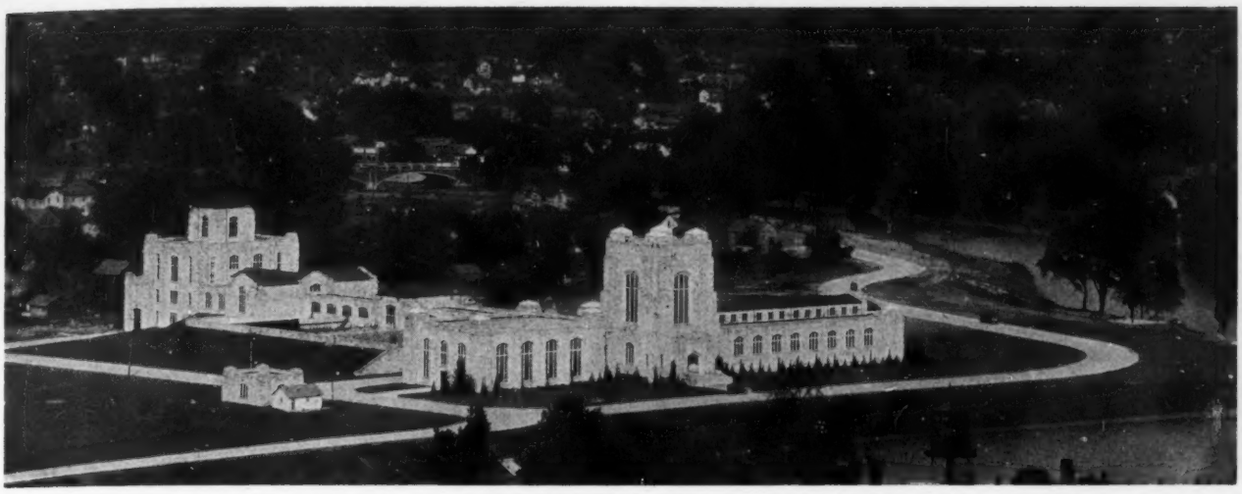


Water Works Park Filtration Plant. (Largest Single Plant in the World)

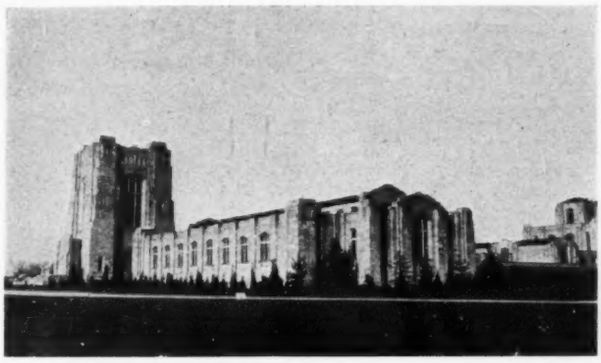
The New Springwells Plant

Operating Galleries at Springwells Filter Plant

Fort Wayne and Saginaw



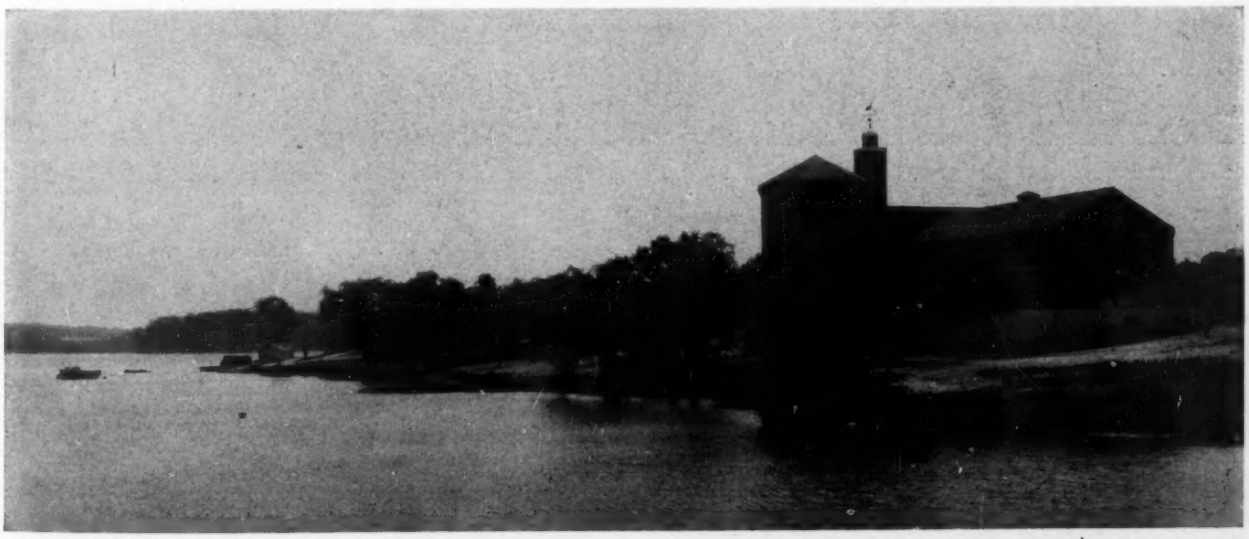
Air Travelers Know That Fort Wayne, (Ind.) Has a Most Startling Water Works Plant—Citizens Agree.



Fort Wayne, Ind.
(Softening and Filtration)
A Plant Beautiful from Every Angle. And is Fort Wayne Proud of Its No. 1 *Utility?*

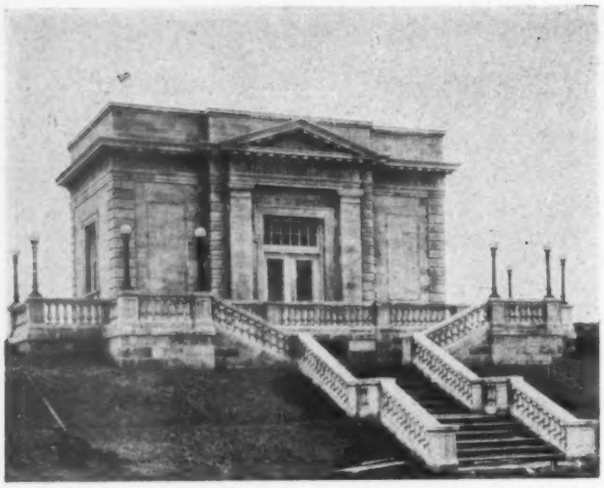
Saginaw, Mich.
(Softening and Filtration)
For Several Years Considered America's Most Remarkable Plant—Both in Appearance and Cost.
(Hood, Decker, Shoecraft, Drury & McNamee—Engrs.)

Bloomington, Ill.



This "Chateau on the Lake" at Bloomington, Ill., Is the City's Softening Filtration Plant. The Lake Is Used for Regulated Recreational Use—Has a 14 *Mile Shore Line. (Alvord, Burdick and Howson, Engrs.)*

Louisville, Ky.



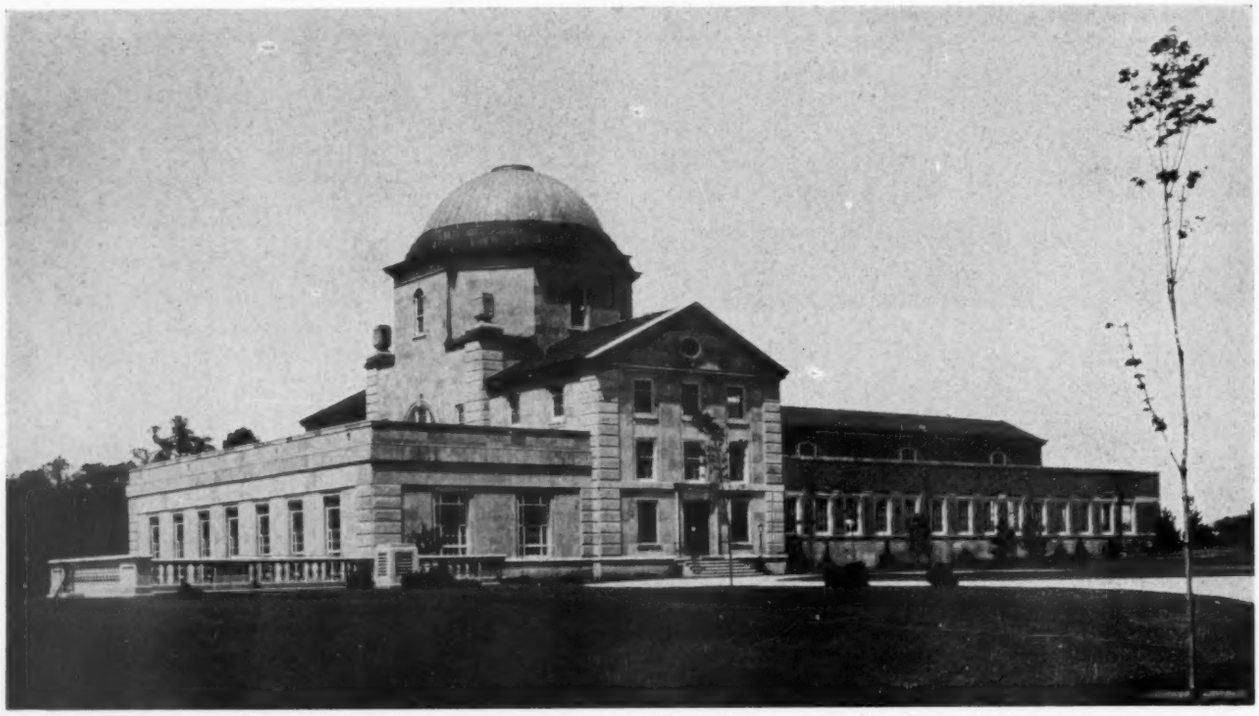
Gate House of Earth-Covered Filtered Water Reservoir on Cardinal Hill

Des Moines, Ia.

(A Beauty Spot) Entrance to Water Works, Looks Across a Lily Pond with Landscaped Surroundings—Made from an Old Borrow Pit and Eye-Sore.

(Alvord, Burdick and Howson, Engrs.)

Erie, Pa.

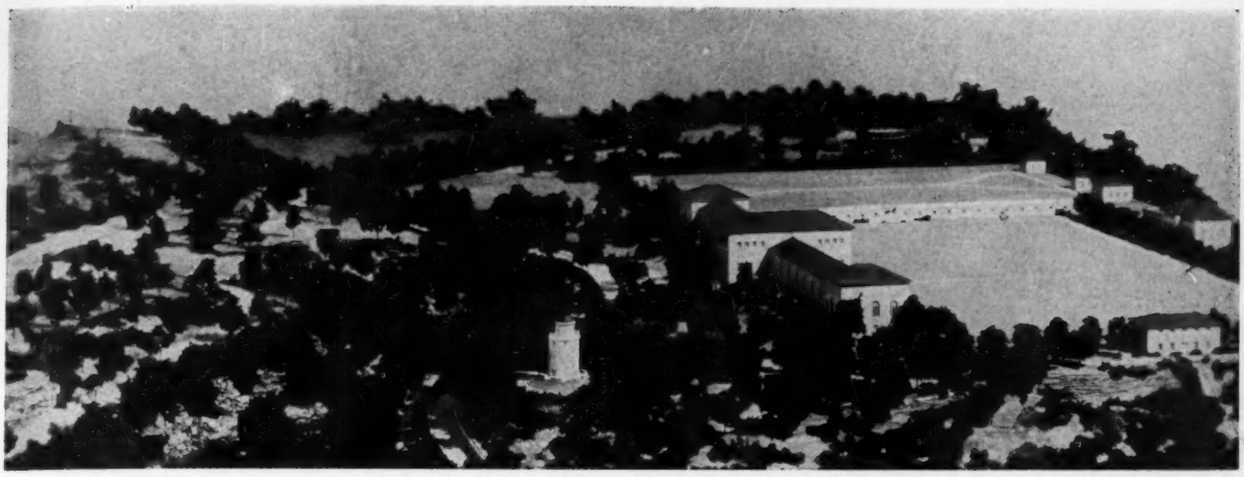


New West Side Filtration Plant and Pumping Station. (Chester, Laboon, Campbell, David & Bankson, Engrs.)

Operating Floor of New Erie Plant.

Low Duty Pumping Station on Lake Erie.

Cleveland, Ohio



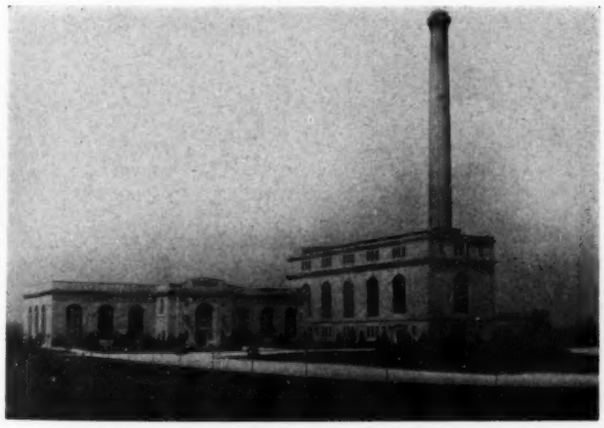
Baldwin Filters and Reservoir—Looking Toward the Lake (Erie)—The Newer of the two Cleveland Plants.

Filter Operating Floor, Baldwin Filters, 20 Units

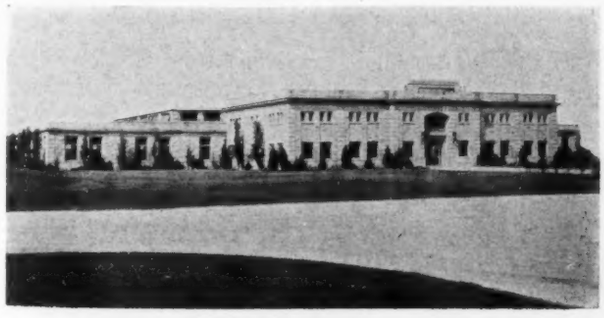
At Baldwin Filters Is Largest Covered Reservoir in the World. A Hall of Columns—1196 in Number and 30 inches in Diameter. 135,800,000 G. Cap.

St. Louis, Mo.

Howard Bend Plant.



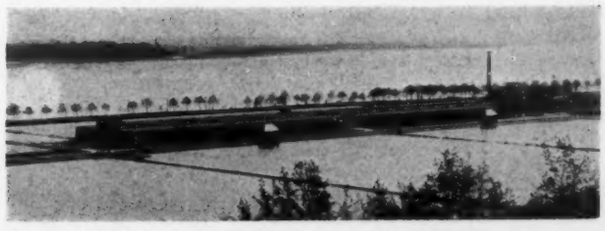
Power House and Pumping Station



Filter House

St. Louis, Mo.

Head House, Howard Bend Plant



Chain of Rocks Filter Plant and Pumping Station

Two Historical Wisconsin Plants

Above—First Filtration Plant. (1896 — Slow Sand) (Ashland, Wis.)
Below—First Softening Plant (Columbus Wis.)

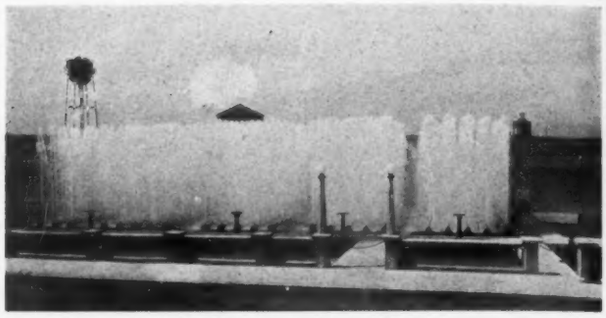
Minneapolis, Minn.

Washburn Park—Stand Pipe, 60 ft. Diameter—75 feet high. 1,500,000 Gals. Reinforced Concrete—Hewitt System.

Dallas, Tex.

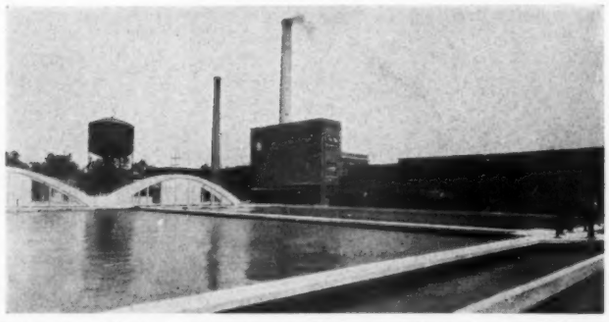
One of Several Suburban Booster Stations.

Denver, Colo.



Marston Lake (North) Filtration Plant. Above—Aerators (600 Nozzles). Below—Filters (Anthracite beds). (James A. Fuertes, Engr.)

Springfield, Ill.

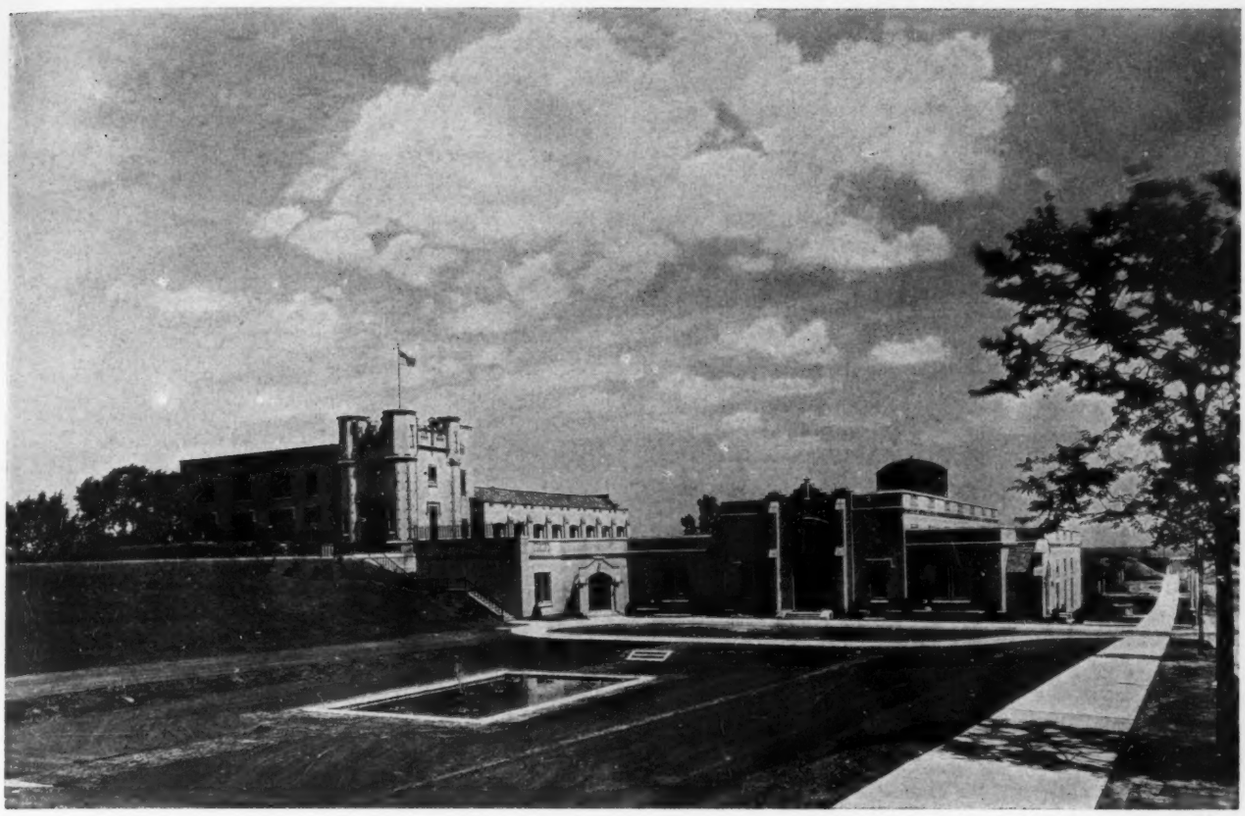


Softening-Filtration Plant. Second Plant in America to Use the Ammonia-Chlorine Process.

Lancaster, Ohio

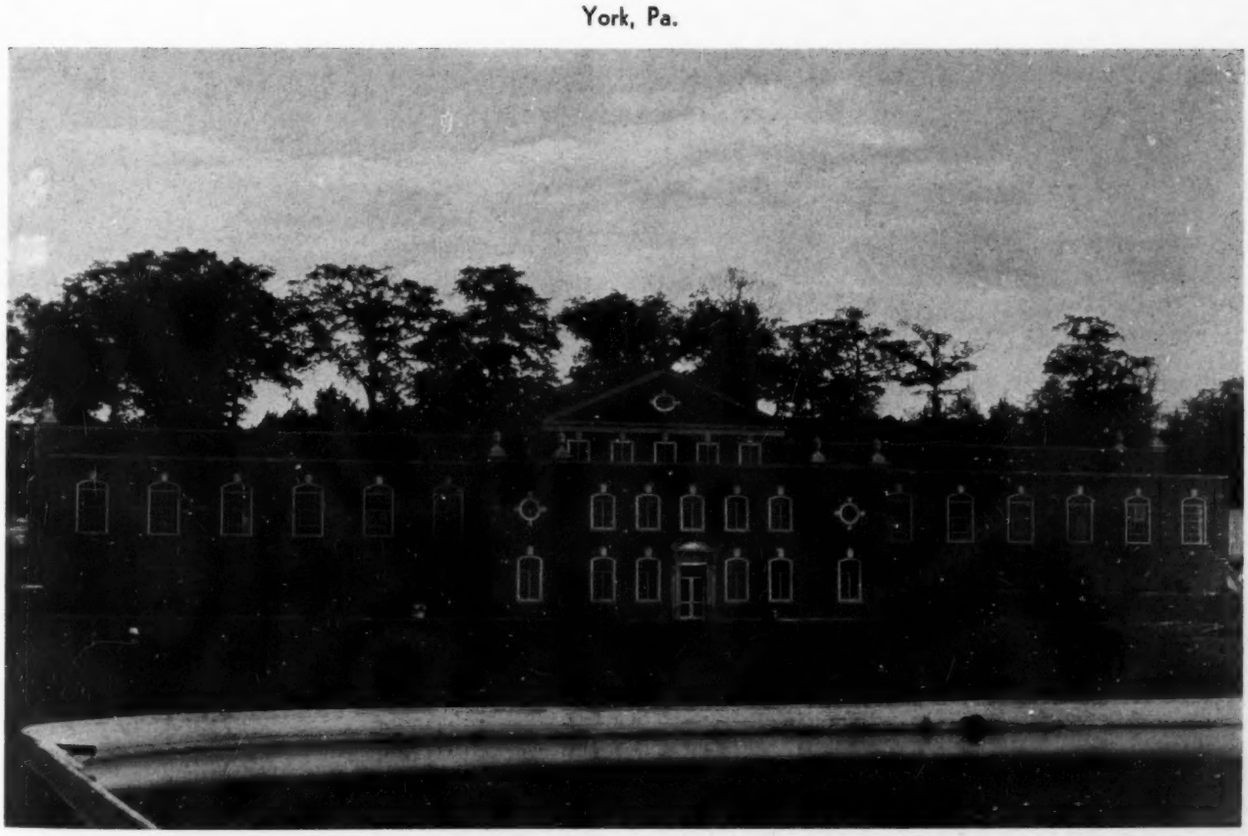
Softening-Filtration Plant, Zeolitic Process (Chas. P. Hoover, Engr.)

Racine, Wis.



Pumping Station and Filtration Plant. (W. A. Pierce, Manager)

York, Pa.



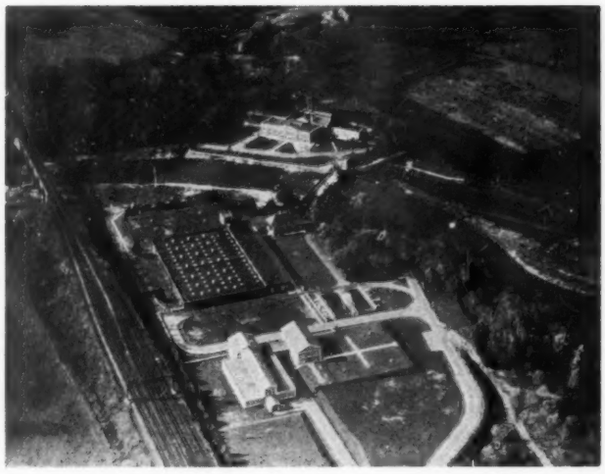
12 *MGD. Filtration Plant, Completed in* 1932,*York Water Co. (Fuller & McClintock, Engineers)*

Nashville, Tenn.

Water Works Plant—Power and Pumping Station (left). 30 M.G.D. Filtration Plant (center). (J. N. Chester Engr.)

Lancaster, Pa.

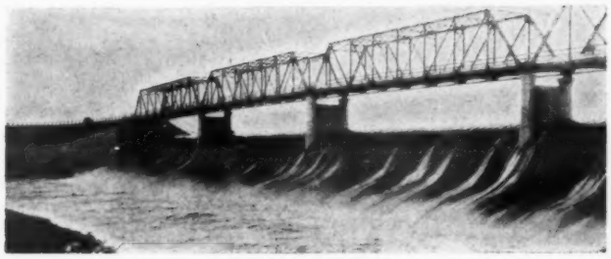
(More Beautiful than Pictures Reveal) Above—New Filtration Plant. (16 M.G.D.) Right—Air View Showing New Plant (Near); Old Slow Sand Plant (Center) Converted to Aeration Unit; New Pumping Station Across Conestoga Creek; Between New and Old Filters to Right is the First Dorr Clarifier. Installed for Water Purification, According to Jas. J. Malone, W. W. Supt. (Chester, Laboon, Campbell, Davis & Bankson, Engrs.)



Wanaque, N. J.

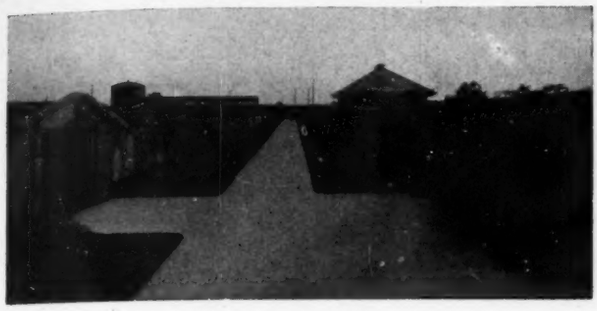
(North Jersey District Water Supply) Wanaque Dam and Head Works. Aeration, Ammoniation, Chlorination, Automatic pH Adjustment for Corrosion Control.

Dallas, Tex.

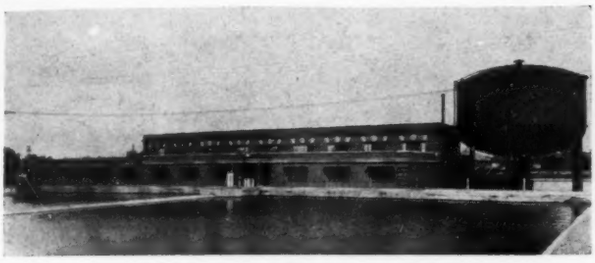


Lake Dallas Spillway

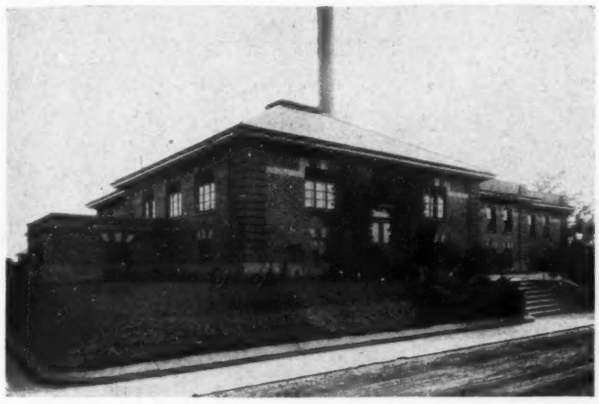
Indianapolis, Ind.
(Indianapolis Water Co.)



Slow Sand Filters



Rapid Sand Filtration Plant



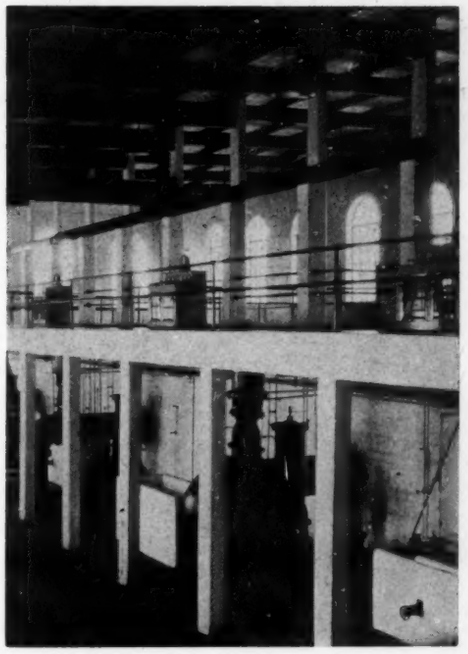
Pumping Station

Bluefield, Va.

Filtration Plant—An Example of Small Plant Beautification with Donated Shrubs and Plants from Interested Citizenry.

Durham, N. C.

Above—Power and Filtration Plant (Pumping by Water Wheel Drive). Below—Filter Gallery and Pump Room. (Wm. M. Piatt, Engr.)



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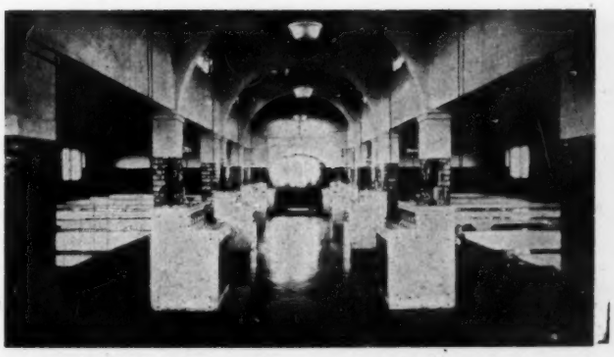
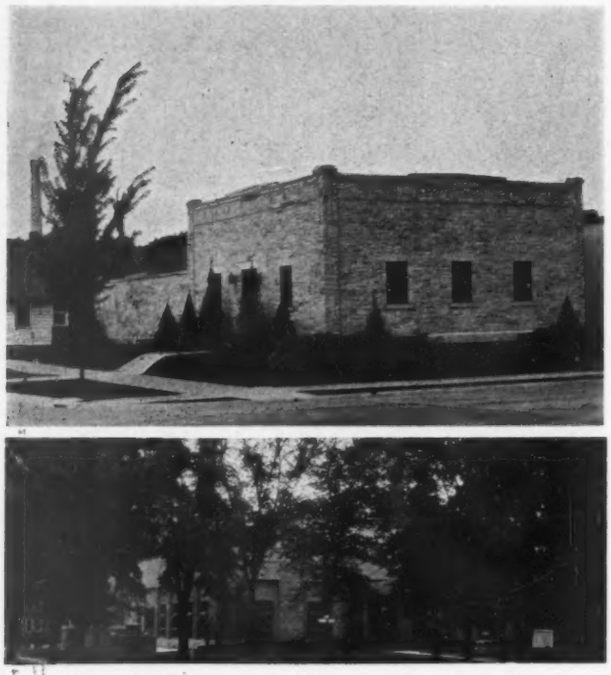
High Point, N. C.



Filtration Plant and Pumping Station. Filter Operating Floor (below) (Wm. C. Olsen, Engr.)

Madison, Wis.

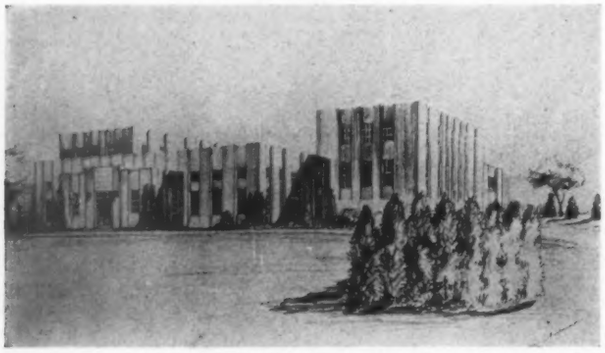


(Deep Wells) Main Pumping Station and Station at Well No. 4.

Lemoyne, Pa.

(Riverton Consol. Water Co.) A Quaint Little Filter Plant in a Picturesque Setting. Originally an Old Grist Mill (1775). Operator's Home on Right. Plant Operates on Water Power.

Lincoln, Neb.



New Iron Removal-Filtration Plant. (Black and Veach, Engrs.)

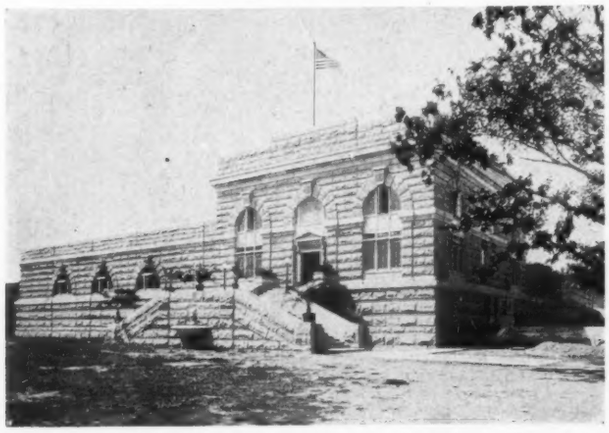
Two Zeolite Softening Plants

Sewickley, Pa. (Above) The First Gravity Zeolitic Municipal Softening Plant in America, 2 M.G.D. Cap. Ambridge, Pa. (Below) Combination Softening-Iron and Manganese Removal Plant (2 M.G.D.)—7 p.p.m. Manganese Being the Record for Any American Supply. (J. N. Chester, Engrs.)

Oklahoma City, Okla.

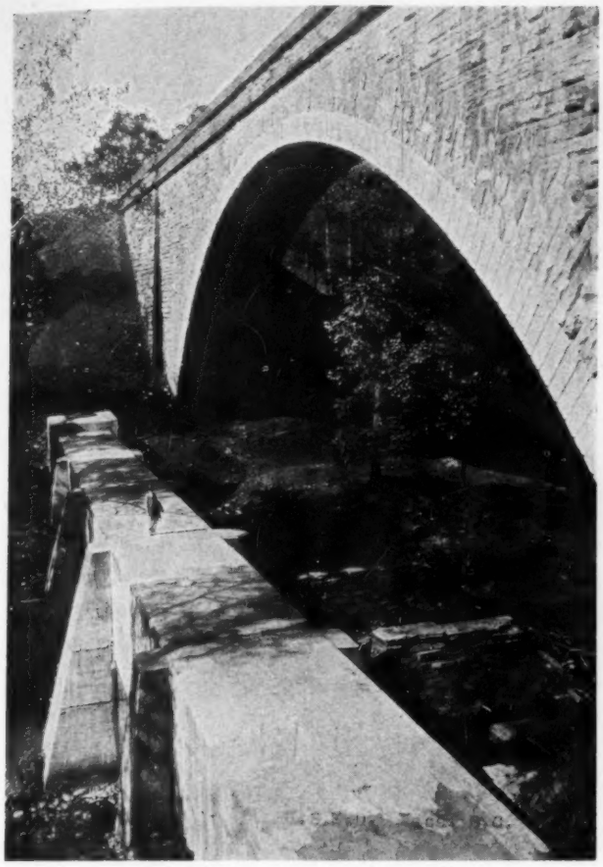
Softening-Filtration Plant. Coagulant Generated from Chlorine Water Passing upward through a Tower Filled with Iron Scrap.

Topeka, Kansas



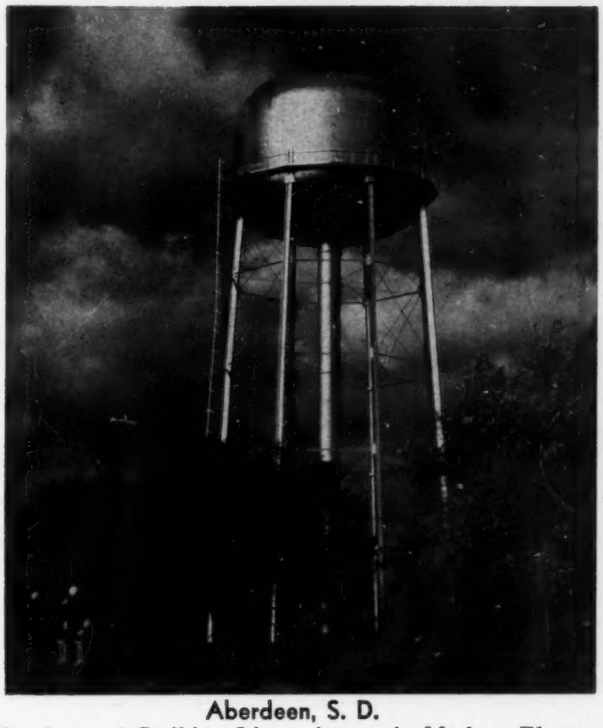
Softening-Filtration Plant. (Black and Veach, Engrs.)

Old and New



Washington, D. C.

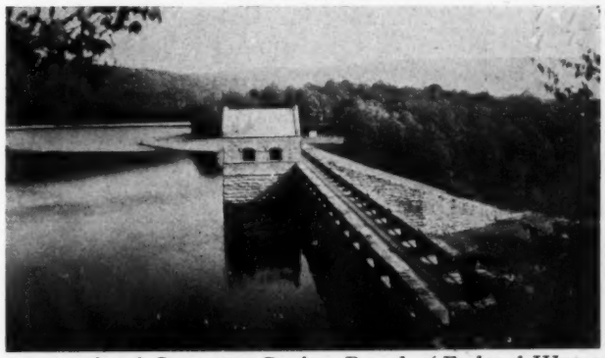
Cabin John Bridge—Has the largest masonry arch in America. Contains 80 M.G.D. Conduit to Washington Invert Syphon below—125 M.D.G. cap.



Aberdeen, S. D.

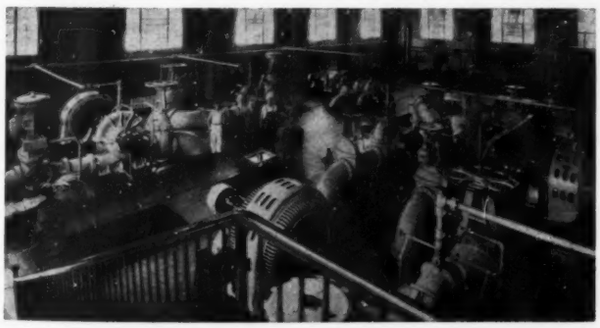
Pleasing and Striking Lines Appear in Modern Elevated Tanks Such As This Recent Installation. Competition in Tank Beautification Has Been Responsible for This Advance.

Scranton, Pa.



Reservoir of Scranton-Spring Brook. (Federal Water Service Co.)

Dayton, Ohio

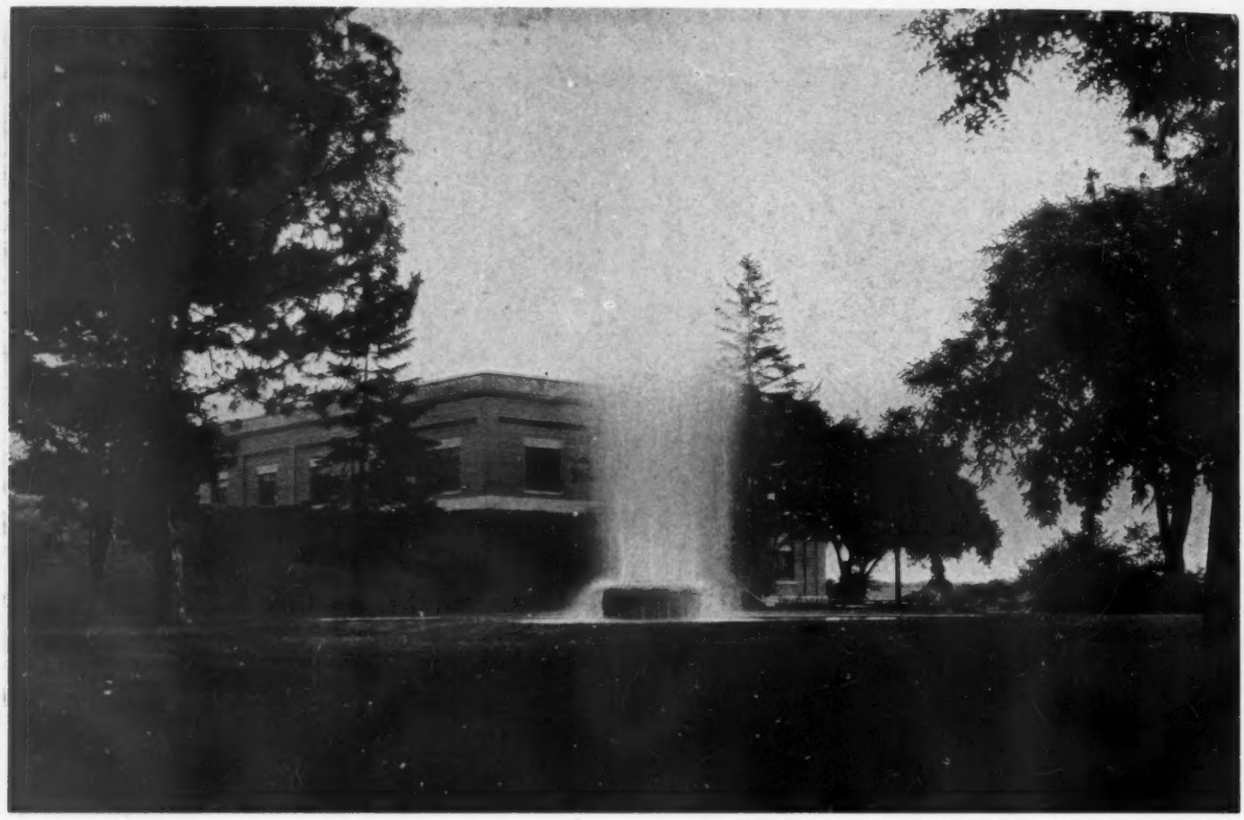


Above—Pumping Station. Below—Pump Room.

Portage, Wis.

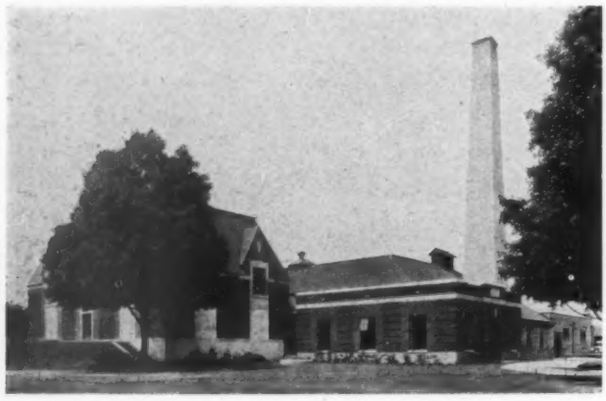
Filtration Plant Located in a Beauty Spot on the Wisconsin River.

Peterborough, Ontario, Canada



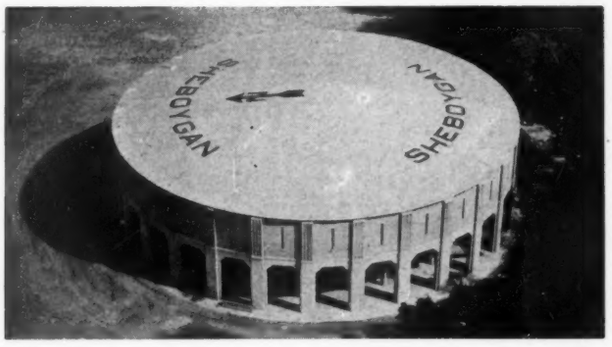
Filtration Plant Behind Illuminated Fountain. Utilities Commission—R. L. Dobbin, Genl. Mgr.

St. Thomas, Ont., Canada



Filtration Plant and Pumping Station

Sheboygan, Wis.

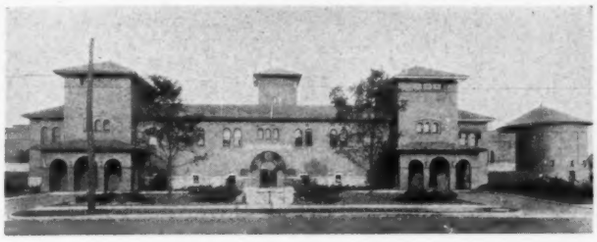


Above—Sheboygan's Novel Brick Cased Steel Reservoir Floats on the System and Holds 4 Million Gallons. Has Made Life Easier for Supt. Arthur H. Miller and His Operating Personnel. Below—A Poor Picture of An Attractive Filtration Plant.

Grosse Point Farms, Mich.

Filtration Plant (Shoecraft, Drury & McNamee, Engrs.)

Grand Rapids, Mich.



Above—Main Pumping Station. Below—Softening-Filtration Plant. One of the First Large Municipal Softening Plants. (Fuller and McClintock, Engrs.)

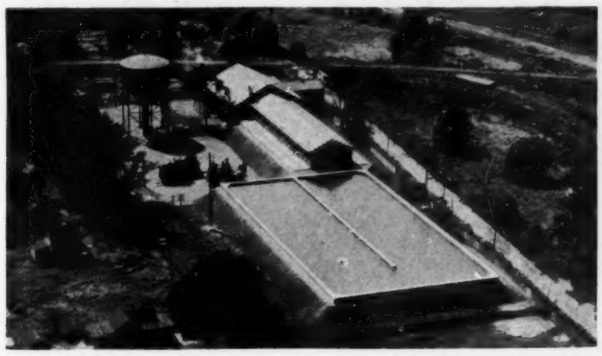
Akron, Ohio

Above—Filtration Plant. Below—Operating Gallery.

Canal-Winchester, O.

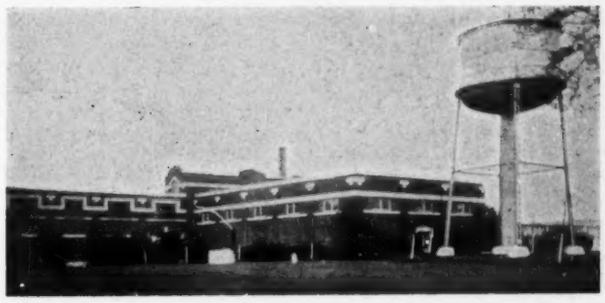
New Softening-Filtration Plant Designed to Conform to Architecture of Residential District Surrounding. Not Yet Landscaped. (C. T. Kaiser, Engr.)

Buffalo, N. Y. (Suburban)



(Federal Water Service Co.) Woodlawn Filtration Plant of Western N. Y. Water Co.

High Point, N. C.

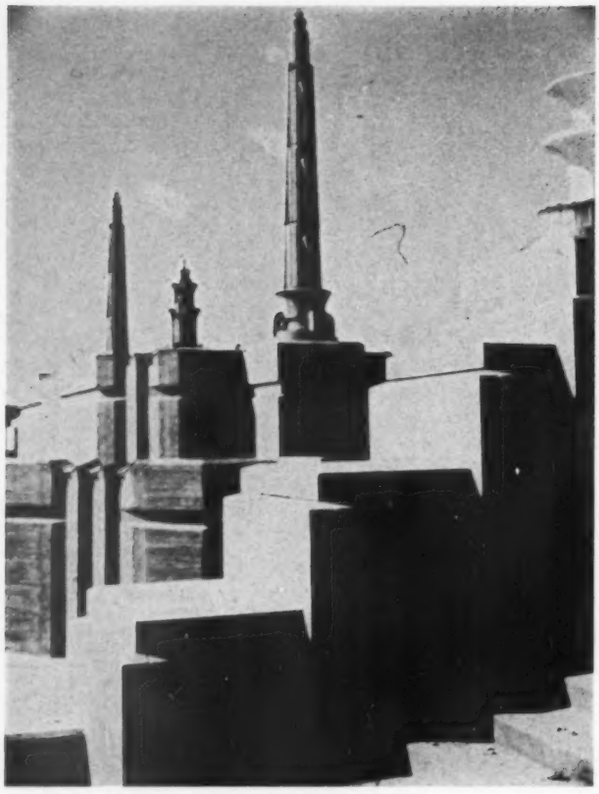


Filtration Plant and Pumping Station. (Wm. *C. Olsen, Engr.*)

Dallas, Texas

Bachman's Filtration Plant

Wilmette, Ill.



Approach to New Filtration Plant (Greely and Hansen, Engrs.)

Baintree, Mass.

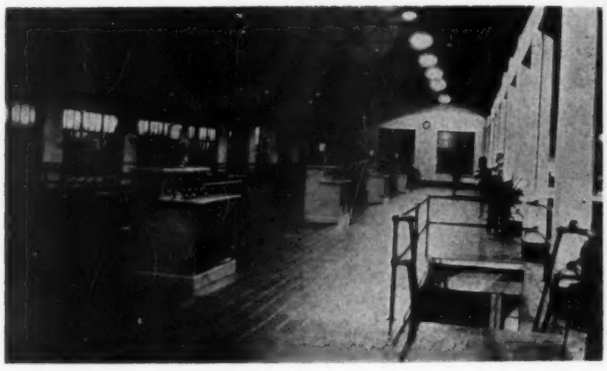
New Filtration Plant Equipped with Wheeler False Bottom. (Weston & Sampson, Engrs.)

Fremont, Ohio

Softening-Filtration Plant. 1 M.G.D.

Charlotte, N. C.

Above—Filtration Plant. Below—Operating Floor (Wm. M. Piatt, Engr.)



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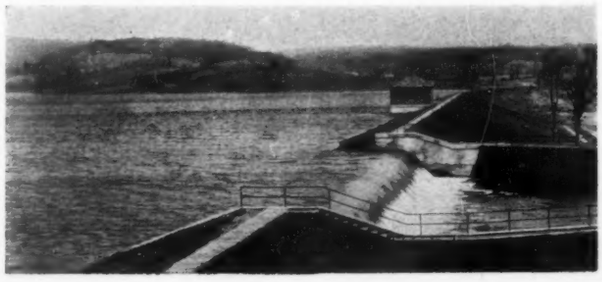
Albany, N. Y.

New All Gravity Water Supply: Above—32 M.G.D. Filtration Plant. Below—Dam and Alcove Reservoir Soft Water Supply—20 mi. from Albany. (Whitman, Requardt & Smith, Engrs.)

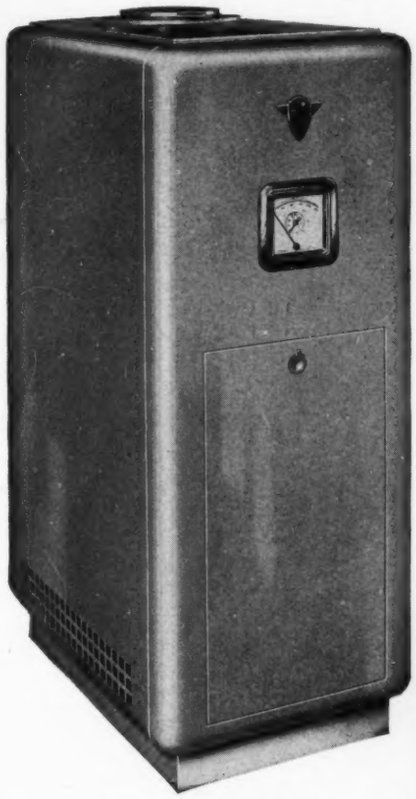


NEW EQUIPMENT AND LITERATURE

An "Ideal" Furnace for Burning Sludge Gas

The American Gas Products Corporation (a division of American Radiator Co.) has recently announced the Empire, a new gas fired hot water furnace, particularly suitable for sewage treatment plants.

The gas burners have been correctly designed and especially adapted for properly burning sludge gas. All sheet metal parts exposed to the action of flue-gases are finished in acid resisting vitreous enamel. Careful consideration has been given the matter of control of the high heat value of digester gas, the complete control being centered in a *single compact valve mechanism* which performs several functions. The gas can, by a simple adjustment, be throttled against any pressure or temperature to any predetermined minimum flow to the burners. Thus, any desired water temperature or steam pressure to meet individual requirements is assured. A thermostatic pilot and automatic gas pressure governor are standard equipment. For steam boilers an automatic low water cut-off is included. Such a compact heating control device has been found especially suitable for heaters in sewage works where rapid circulation and relatively low hot water temperature is desired. A mechanical limit control shuts off the gas completely in the event that the recirculation pump fails.



Arco "Ideal" Furnace

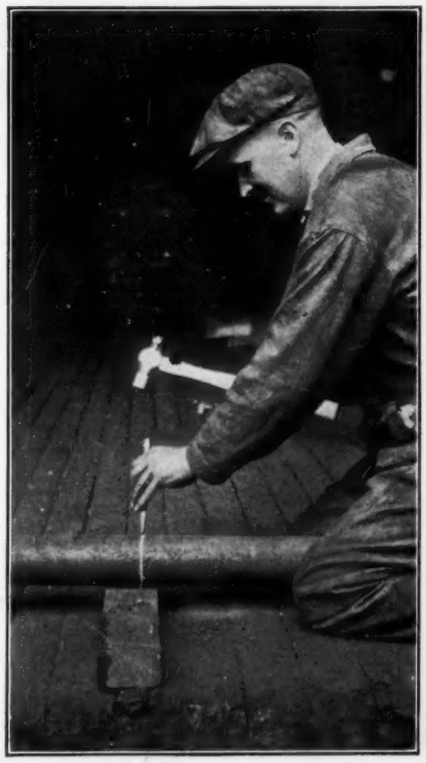
The thoroughly insulated boiler is encased in a neat vitreous enameled metal jacket. The patented and featured vertical cast iron heating section in the Empire Model Heater possesses a rapid and efficient heat absorption capacity for a rated output of 105,000 B.t.u. per hour. Other Ideal boilers, which are available in 37 different sizes and deliver from 31,500 to 3,840,000 B.t.u. per hour, have already been installed in 20 or more treatment plants.

For further information and a description of the compact gas control mechanism ask for literature on the Empire Model Ideal Gas Boiler. Address American Gas Products Corp., 40 W. 40th St., New York City.

▼

Stanley Non-Sparking Tools

The ever increasing fire and explosion hazards from sludge and sewer gas makes the availability of the recently perfected non-sparking tools of timely interest in the sewerage field. The new Anaconda Beryllium-Copper alloy, introduced by American Brass Company, has the property of great hardness, such as is required for cutting chisels, hammers, pick axes, screw drivers, scraping tools, punches, pry bars and the like, without production of sparks when working with them on sparking metals.



Non-Sparking Tool in Use

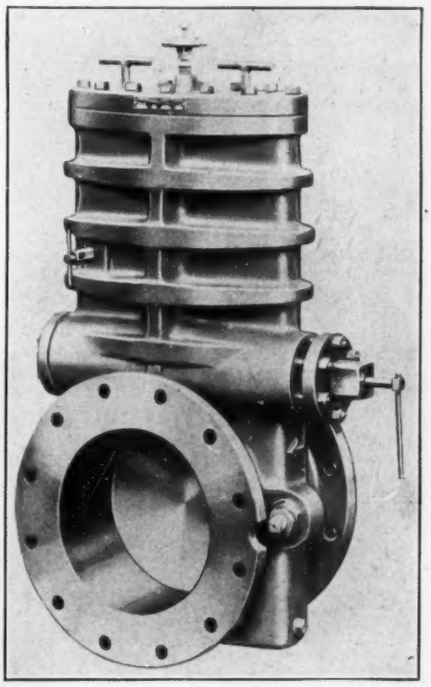
Stanley Tools, New Britain, Conn., have recently announced a complete line of Beryllium-Copper non-sparking tools equal in hardness (390 Brinnell) to spring tempered spring steel. High in first cost any worn or damaged tools have a high return value toward the purchase of new tools. A set of these non-sparking tools should be available to every Sewer Department and especially at every sewage treatment plant

For a bulletin giving complete description of the new non-sparking safety tools address the alloy producers, American Brass Company, Waterbury, Conn.; the tool manufacturers, Stanley Tools, New Britain, Conn., or this magazine.

▼

Complete Metering Equipment Now Supplied by Foxboro

The Foxboro Company has been made sole distributors of "Commercial" Orifice Fittings, made by the Commercial Iron Works of Los Angeles, Calif. The Foxboro Company is thereby now in a position to supply the complete metering set-up, including indicating and recording units for which Foxboro have become so well known.

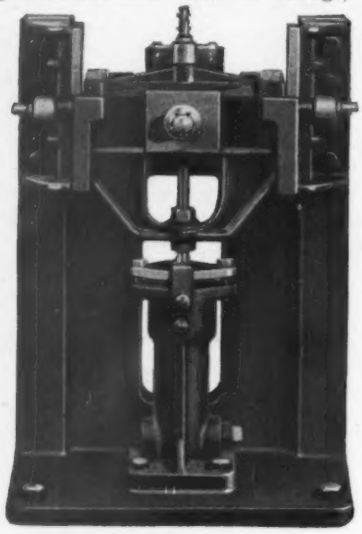


"Foxboro Commercial" Orifice Meter Fitting

"Commercial" Orifice Fittings offer the following advantages: The need for by-passes is eliminated entirely, and there is a decided saving in space. The threaded elevator lift permits lowering or raising of orifice plates regardless of line pressure. Then, without shutting down the line, and also with complete safety to the operator. Additional features include the accurate centering of orifice plates and elimination of set screws in pressure areas. For more complete details, address The Foxboro Company, Foxboro, Mass.

Dearborn Chemical Feed Pump

A new chemical feed pump has been announced by the Dearborn Chemical Company. It was developed especially for delivery of exact quantities of treating chemicals into water or sewage, dependent upon the rate of flow. Smooth, steady action, without lost motion, is attained through the centered ball bearings and guided plunger. Stroke adjustment can be set accurately from 0 to 3 in. for complete cylinder displacement and elimination of air pocketing. Plungers are special alloy and all working parts are "nickel semi-steel." The plungers and cylinders, designed for high or low pressures, are interchangeable from ½ in. to 3 in. in diameter.



Dearborn Chemical Feed Pump

This new pump may be operated by any type of actuating device. Height overall is 23½ in. Approximate weight 125 lbs.

For descriptive literature, address Dearborn Chemical Company, 310 S. Michigan Ave., Chicago, Ill.

▼

Pot Impact Wrench

The one-man Pot Impact Wrench recently announced by Ingersoll-Rand Company is not subject to adequate description in the space here available. It is a combination high speed (700 r.p.m.) wrench and tightening or loosening hammer in a single 20 pound machine. Is indispensable for placing or removing boiler stay bolt caps from the underside of boilers and also other bolt nuts in all hard to reach locations. In this wrench entirely new principles in the pneumatic tool field are incorporated. The "accumulator," a cylindrical block of special rubber, is interposed between the "multi-vane" air motor and the chuck. The torgue from the motor when applied to the "accumulator" causes it to twist and become shortened, thus lifting the "hammer" from engagement with the "anvil." The hammer is then released and being spun forward to the next engagement delivers a smart and powerful blow to the anvil on the end of which the chuck is attached. At a rate of 1,200 to 1,400 such blows per minute a more powerful turning effect is produced than has ever before been attained with any portable wrench. This makes possible the removal of nuts which heretofore have had to be split off by chisel or burned off by torch. Its many applications and special features are covered in Descriptive Pamphlet No. 2152. Address Ingersoll-Rand Company, 11 Broadway, New York City, or Phillipsburg, N. J.

Removing Staybolt Caps from Underside of Boiler with Size 533 *Pott Impact Wrench*

Exclusive Impeller Features on "Chicago" Sewage Pumps

Fig. 2050

Fig. 2061

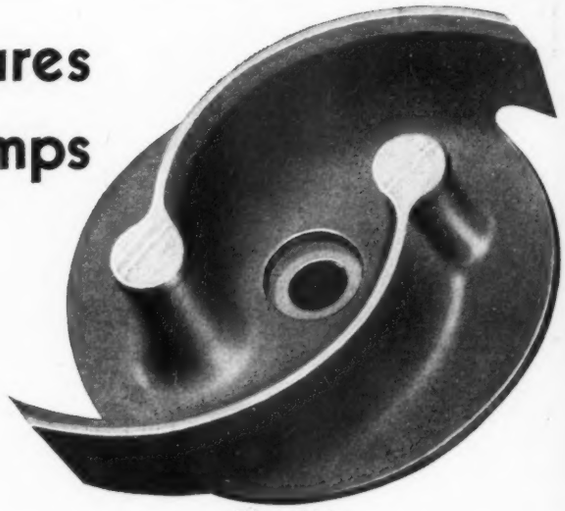


Fig. 1776

Evolution of Non-Clog Impeller

The truly non-clogging impeller which is an exclusive feature in all Chicago Non-Clog Pumps passed through the three stages of development pictured above. Fig. 2050 on the left was the first impeller placed in Chicago Non-Clog Pumps. It was a totally enclosed impeller. Experience proved that an enclosed impeller revolving between the inside faces of the pump casing offered endless surfaces between which material rolled up until it finally bound the pump. To remedy this condition our engineers developed the semi-enclosed impeller, Fig. 2061. It was an improvement, but it did not eliminate the trouble. The wide surfaces of the blades themselves caused material to roll up and bind the pump. That is why the blades of the new impeller, Fig. 1776, are chamfered so that the minimum amount of surface is adjacent to pump casing. The new impeller is entirely open and is truly non-clogging. It was developed after months spent in research work and the designing of many experimental models.

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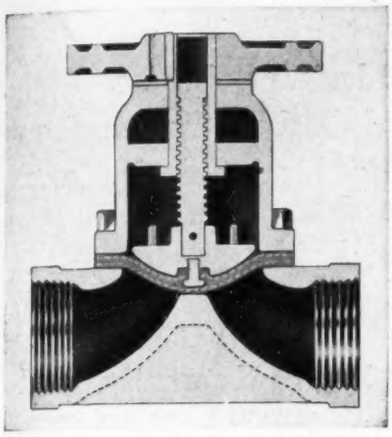
Hills-McCanna Acid-Proof Valves

Protected working parts is featured in the Hills-McCanna (Saunder's Patent) Valve, which becomes of especial interest with the increasing use by water purification and sewage treatment works of the efficient but highly corrosive iron salts



Hills-McCanna (Saunders Patent) Valve

such as ferric chloride, chlorinated copperas and ferric sulphate.

The cut is self-descriptive of this novel and trouble free valve in a closed position. The body and bonnet containing the working parts are two distinct units completely separated by the acid resistant resilient diaphragm which protects the working parts and serves to "pinch" off the flow or control it. These trouble proof valves are available in screw or flanged ends from ½ in. diameter upwards in lead lined or rubber lined iron, ceramic materials, cast iron, bronze or stainless steel.

For descriptive literature and specifications address Hills-McCanna Company, 2349 Nelson Street, Chicago, Ill.

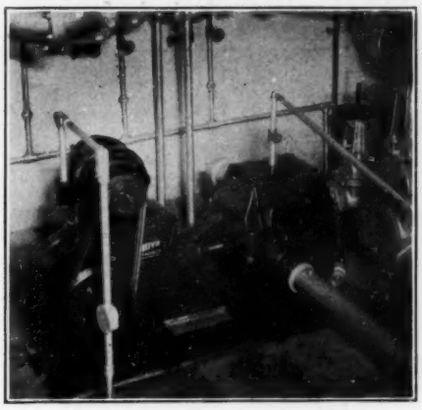
▼

Novo Roller Ring Sludge Pump

Something entirely new in the line of sludge pumps has just been announced by NOVO Engine Company of Lansing, Mich. After a period of two years of operation in actual sewage plant service, this novel pump which features rubber roller-rings on the horizontal plungers to produce a positive seal, is now considered proven and ready for the market.

The new NOVO Roller Ring Sludge Pump is designed with top suction and bottom discharge to insure straight line gravitational sludge flow to minimize agitation and gas release. To this end, and for power and maintenance economy, the variable speed of its plunger travel has been reduced to 30 to 50 strokes per minute. To minimize operation difficulties and necessity of cleaning, an exceptionally large vertical valve opening (21.6 sq. in. area) is being featured along with the grease resistant rubber roller ring bearing and seal. For flushing out, a 1-in. water connection to the top and a 2-in. drain plug for piping away the flush water are provided. The flow through the pump from top to bottom makes cleaning of passage ways and valves possible with but a few strokes of the plunger, thus eliminating the necessity of removing hand-hole plates or valves. Cleaning is thereby accomplished in a cleanly manner.

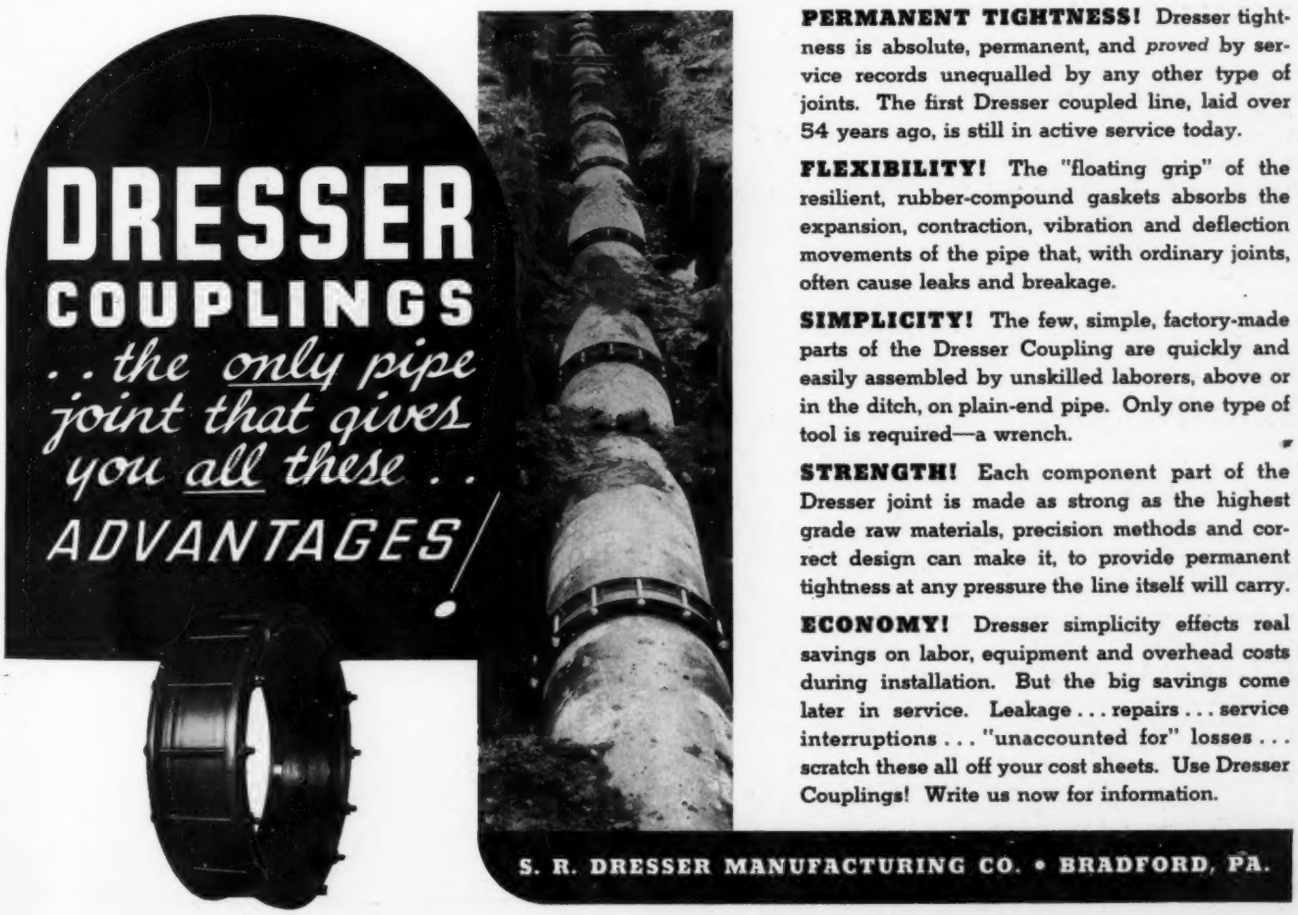
The outstanding feature of this pump is the unique method of sealing the plunger. Two rubber rolling rings form-



NOVO Sludge Pump

ing the bearing and water tight seal between the plunger and the cylinder wall make for quiet positive action and reduces power by serving as frictionless and cushioned roller bearings. Thus also is wear by grit and packing eliminated as is the expense and time required in repacking.

The unit is driven by a 3 H.P. motor with variable V belt drive—portable units being equipped with gasoline engine, truck mounted.



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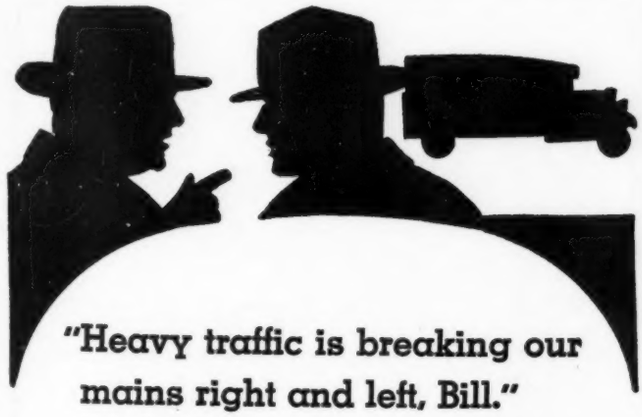

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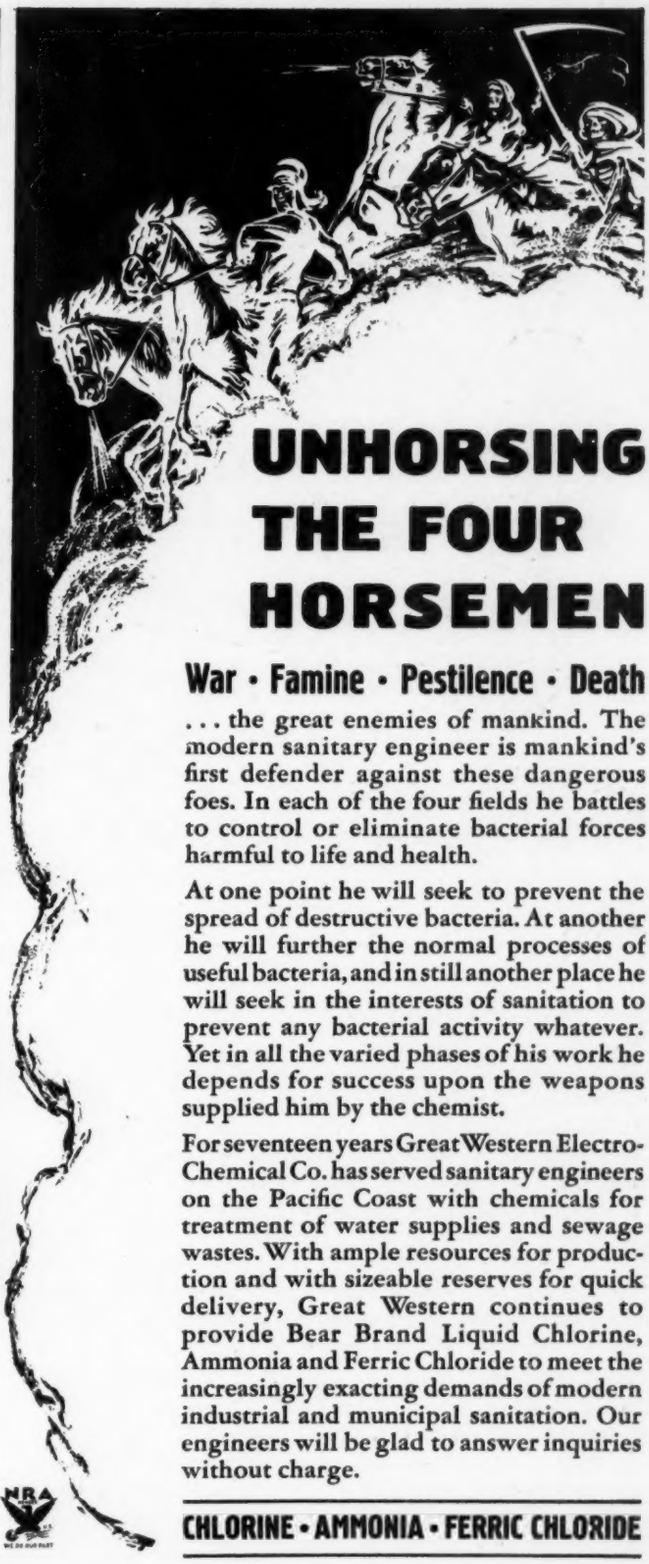

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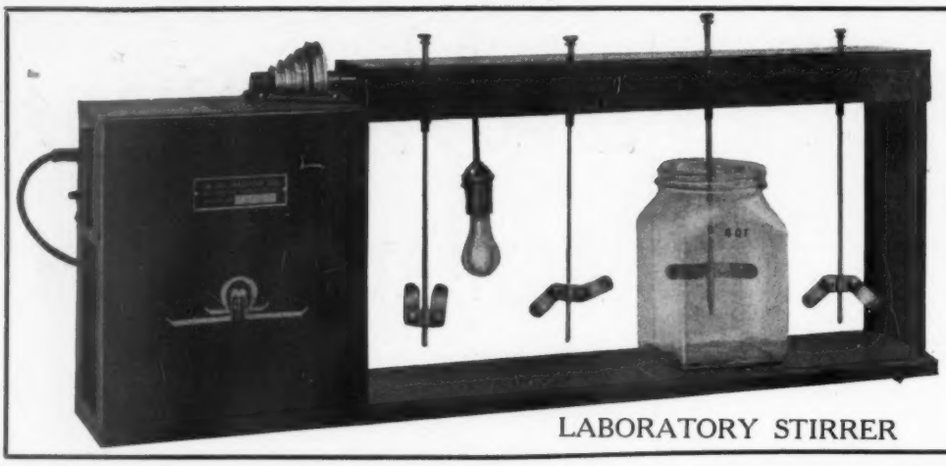

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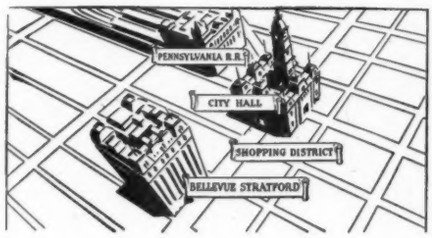

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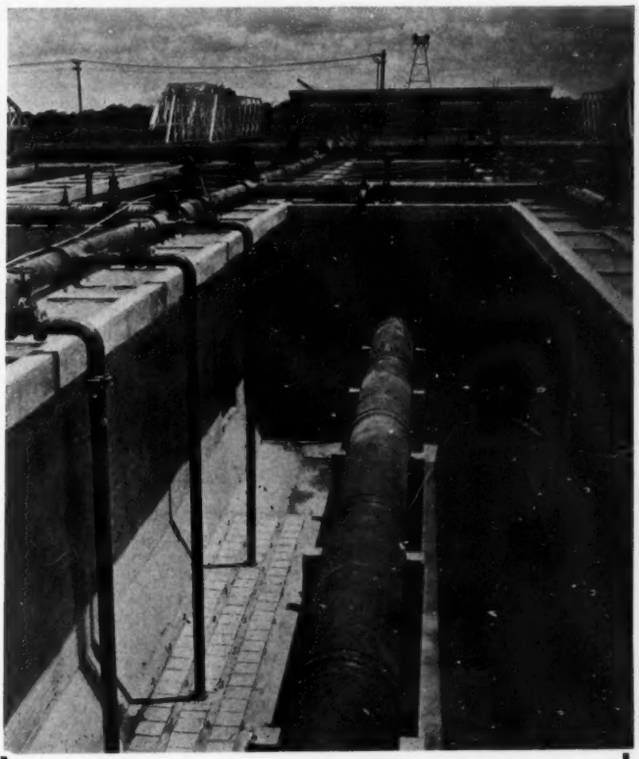

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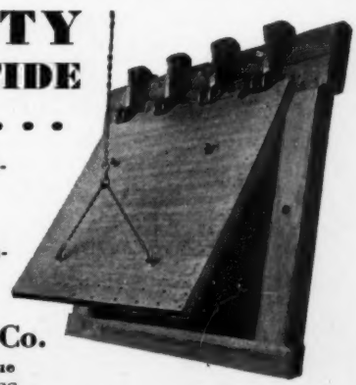

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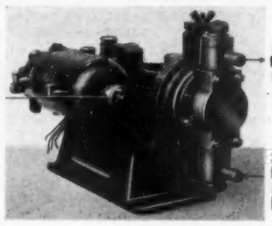

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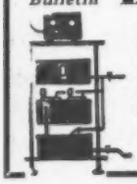

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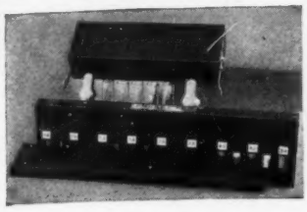

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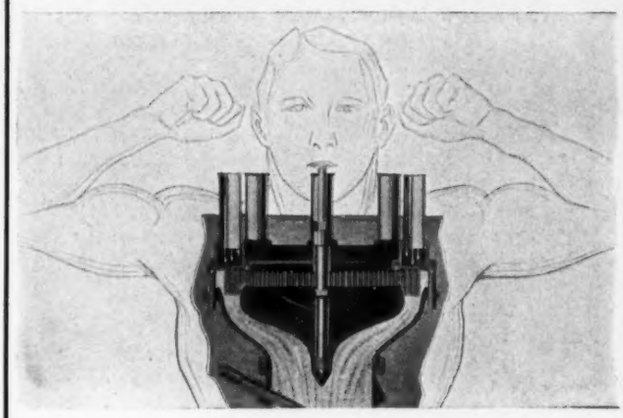

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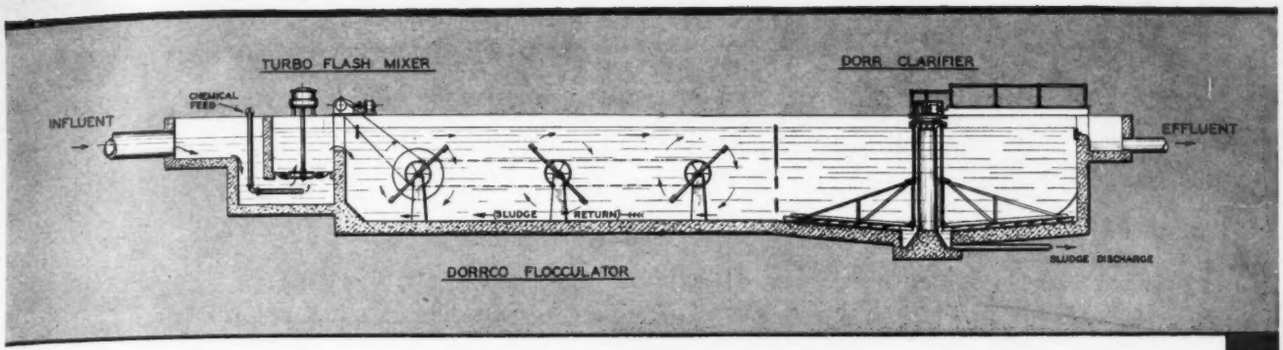

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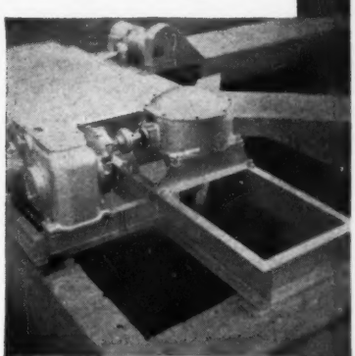

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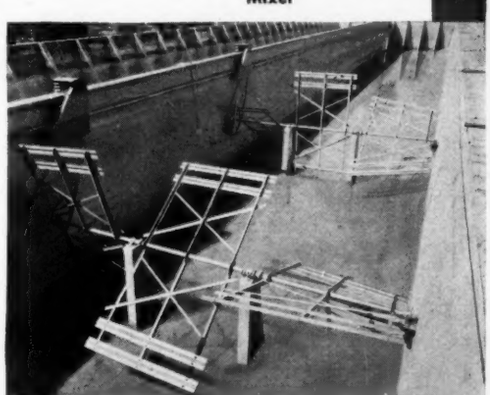

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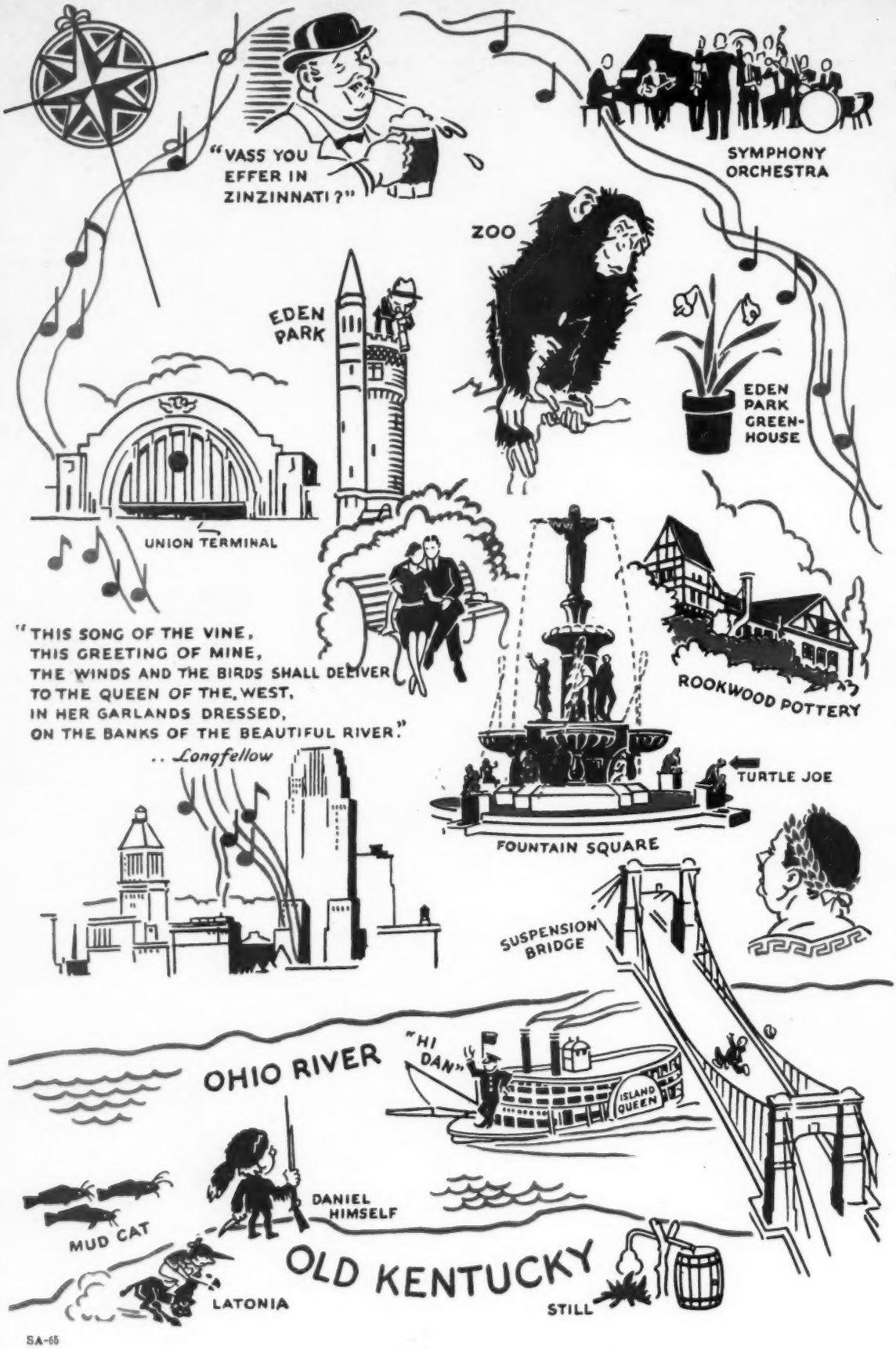

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